This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

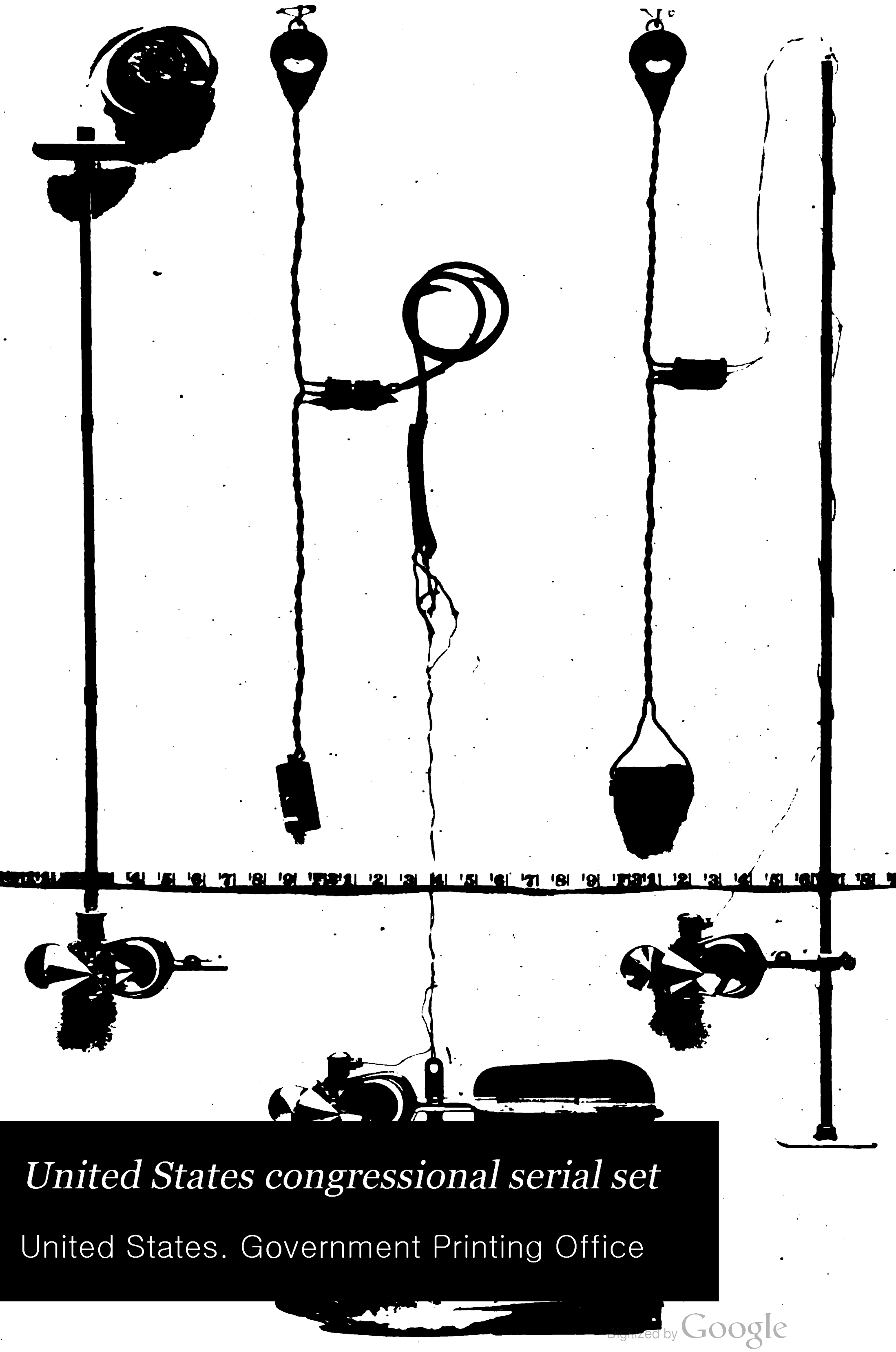
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



United States congressional serial set

United States. Government Printing Office

U S Doc ~~[illegible]~~

US Doc 445

HARVARD UNIVERSITY
GRADUATE SCHOOL
OF BUSINESS
ADMINISTRATION
BAKER LIBRARY

GIFT OF

NEW LONDON PUBLIC LIBRARY

TRANSFERRED
TO
HARVARD COLLEGE
LIBRARY

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPERS

Nos. 267-269

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

U.S. Doc [illegible]

US Doc 445

NEW LONDON
PUBLIC LIBRARY
G

CONTENTS

Water-supply paper 267; Surface water supply of United States, 1909, pt. 7, Lower Mississippi basin.

Same 268; Surface water supply of United States, 1909, pt. 8, Western Gulf of Mexico.

Same 269; Surface water supply of United States, 1909, pt. 9, Colorado River basin.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 267

SURFACE WATER SUPPLY OF THE UNITED STATES

1909

PART VII. LOWER MISSISSIPPI BASIN

PREPARED UNDER THE DIRECTION OF M. O. LEIGHTON

BY

W. B. FREEMAN AND R. H. BOLSTER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

CONTENTS.

Page.

- Introduction 5
  - Authority for investigations 5
  - Scope of investigations 6
  - Purposes of the work 7
  - Publications 8
  - Definition of terms 11
  - Convenient equivalents 12
  - Explanation of tables 13
  - Field methods of measuring stream flow 14
  - Office methods of computing and studying discharge and run-off 19
  - Accuracy and reliability of field data and comparative results 26
  - Use of the data 27
  - Cooperative data 28
  - Cooperation and acknowledgments 28
  - Division of work 29
- Gaging stations maintained in the lower Mississippi River basin 29
- White River drainage basin 32
  - Description 32
  - White River at Beaver, Ark 33
  - White River near Branson, Mo 34
  - White River near Leadhill, Ark 35
  - White River near Cotter, Ark 36
  - White River at Walls Ferry, Ark 36
  - Buffalo River near Gilbert, Ark 37
  - North Fork River near Henderson, Ark 38
  - Little Red River near Pangburn, Ark 38
- Arkansas River drainage basin 39
  - Description 39
  - Arkansas River at Salida, Colo 42
  - Arkansas River at Canon City, Colo 43
  - Arkansas River at Pueblo, Colo 46
  - Arkansas River at Las Animas, Colo 48
  - Arkansas River at Holly, Colo 49
  - Grape Creek and De Wesse-Dye ditch near Canon City, Colo 51
  - Purgatory River drainage basin 52
    - Description 52
    - Purgatory River at Trinidad, Colo 53
    - Purgatory River near Higbee, Colo 54
    - Purgatory River near Las Animas, Colo 55
  - Canadian River drainage basin 56
    - Description 56
    - Canadian River at Logan, N. Mex 57
    - Cimarron River at Ute Park, N. Mex 60
    - Cimarron River at Springer, N. Mex 63
    - Rayado River at Abreu's ranch, near Cimarron, N. Mex 67
    - Rayado River near Springer, N. Mex 69

Arkansas River drainage basin—Continued.
  Canadian River drainage basin—Continued. Page.
    Mora River and La Cueva Canal at La Cueva, N. Mex 71
    Sapello River at Los Alamos, N. Mex 75
    Ute Creek near Logan, N. Mex 78
Yazoo River drainage basin 80
  Description 80
  Tallahatchie River at Batesville, Miss 81
  Tallahatchie River at Phillip, Miss 82
  Yazoo River at Greenwood, Miss 85
  Coldwater River at Savage, Miss 86
  Yalobusha River at Grenada, Miss 89
  Sunflower River near Ruleville, Miss 91
  Sunflower River at Baird, Miss 92
Miscellaneous measurements in the lower Mississippi River drainage basin ... 93
Index 95

ILLUSTRATIONS.

Page.
PLATE I. Typical gaging stations: *A*, For bridge measurement; *B*, For wading measurement 16
II. Small Price current meters 18
FIGURE 1. Graphic method of determining daily discharge of streams with changeable beds 25

SURFACE WATER SUPPLY OF THE LOWER MISSISSIPPI BASIN, 1909.

By W. B. FREEMAN and R. H. BOLSTER.

INTRODUCTION.

AUTHORITY FOR INVESTIGATIONS.

This volume contains results of flow measurements made on certain streams in the United States. The work was performed by the water-resources branch of the United States Geological Survey, either independently or in cooperation with organizations mentioned herein. These investigations are authorized by the organic law of the Geological Survey (Stat. L., vol. 20, p. 394), which provides, among other things, as follows:

> Provided that this officer [the Director] shall have the direction of the Geological Survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

Inasmuch as water is the most abundant and most valuable mineral in nature, the investigation of water resources is included under the above provisions for investigating mineral resources. The work has been supported since the fiscal year ending June 30, 1895, by appropriations in successive sundry civil bills passed by Congress under the following item:

> For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

The various appropriations that have been made for this purpose are as follows:

Annual appropriations for the fiscal year ending June 30—

1895	$12,500
1896	20,000
1897 to 1900, inclusive	50,000
1901 to 1902, inclusive	100,000
1903 to 1906, inclusive	200,000
1907	150,000
1908 to 1910, inclusive	100,000
1911	150,000

SCOPE OF INVESTIGATIONS.

These investigations of stream flow are not complete nor do they include all the river systems or parts thereof that might purposefully be studied. The scope of the work is limited by the appropriations available. The field covered is the widest and the character of the work is believed to be the best possible under the controlling conditions. The work would undoubtedly have greater scientific importance and ultimately be of more practical value if the money now expended for wide areas were concentrated on a few small drainage basins; but such a course is impossible because general appropriations made by Congress are applicable to all parts of the country. Each part demands its proportionate share of the benefits.

It is essential that records of stream flow shall be kept during a period of years long enough to determine within reasonable limits the entire range of flow from the absolute maximum to the absolute minimum. The length of such a period manifestly differs for different streams. Experience has shown that the records for some streams should cover from five to ten years, and for other streams twenty years or even more, the limit being determined by the relative importance of the stream and the interdependence of the results with other long-time records on adjacent streams.

In the performance of this work an effort is made to reach the highest degree of precision possible with a rational expenditure of time and a judicious expenditure of a small amount of money. In all engineering work there is a point beyond which refinement is needless and wasteful, and this statement applies with especial force to stream-flow measurements. It is confidently believed that the stream-flow data presented in the publications of the Survey are in general sufficiently accurate for all practical purposes. Many of the records are, however, of insufficient length, owing to the unforeseen reduction of appropriations and consequent abandonment of stations. All persons are cautioned to exercise the greatest care in using such incomplete records.

Records have been obtained at more than 1,550 different points in the United States, and in addition the surface water supply of small areas in Seward Peninsula and the Yukon-Tanana region, Alaska, has been investigated. During 1909 regular gaging stations were maintained by the Survey and cooperating organizations at about 850 points in the United States, and many miscellaneous measurements were made at other points. Data were also obtained in regard to precipitation, evaporation, storage, reservoirs, river profiles, and water power in many sections of the country and will be made available in the regular surface water-supply papers and in special papers from time to time.

PURPOSES OF THE WORK.

The results contained in this volume are requisite to meet the immediate demands of many public interests, including navigation, irrigation, domestic water supply, water power, swamp and overflow land drainage, and flood prevention.

Navigation.—The Federal Government has expended more than $250,000,000 for the improvement of inland navigation, and prospective expenditures will approximate several times this amount. It is obvious that the determination of stream flow is necessary to the intelligent solution of the many problems involved.

Irrigation.—The United States is now expending $51,000,000 on federal irrigation systems, and this amount is far exceeded by the private expenditures of this nature in the arid West. The integrity of any irrigation system depends absolutely on the amount of water available. Therefore investigations of stream flow in that portion of the country are not only of first importance in the redemption of the lands, but constitute an insurance of federal and private investments.

Domestic water supply.—The highest use of water is for domestic supply, and although this branch of the subject is of less direct federal interest than the branches already named, it nevertheless has so broad a significance with respect to the general welfare that the Federal Government is ultimately and intimately concerned.

Water power.—The development of the water power of the country is an economic necessity. Our stock of coal is being rapidly depleted and the cost of steam power is increasing accordingly. Industrial growth, and as a consequence the progress of the United States as a nation, will cease if cheap power is not available. Water power affords the only avenue now open. When the electric transmission of power was accomplished the relation of our water powers to national economy changed entirely. Before the day of electric transmission water power was important only at the locality at which it was generated, but it has now become a public utility in which the individual citizen is vitally interested. Inasmuch as the amount of water power that may be made available depends on the flow of rivers, the investigation of flow becomes a prerequisite in the judicious management of this source of energy.

Drainage of swamp and overflowed lands.—More than 70,000,000 acres of the richest land in this country are now practically worthless or of precarious value by reason of overflow and swamp conditions. When this land is drained it becomes exceedingly productive and its value increases many fold. Such reclamation would add to the national assets at least $700,000,000. The study of run-off is the first consideration in connection with drainage projects. If by the drainage of a large area into any particular channel that channel becomes so gorged with water which it had not hitherto been called upon to convey that overflow conditions are created in places where previously the land was not subject to inundation, then drainage results merely in an exchange of land values. This is not the purpose of drainage improvement.

Flood prevention.—The damage from floods in the United States probably exceeds on the average $100,000,000 annually, and in the year 1908, according to estimates based on reliable data, the aggregate damage approximated $250,000,000. Such an annual tax on the property of great regions should be reduced in the orderly progress of government. It goes without saying that any consideration of flood prevention must be based on a thorough knowledge of stream flow, both in the contributing areas which furnish the water and along the great lowland rivers.

PUBLICATIONS.

The data on stream flow collected by the United States Geological Survey since its inception have appeared in the annual reports, bulletins, and water-supply papers. Owing to natural processes of evolution and to changes in governmental requirements, the character of the work and the territory covered by these different publications has varied greatly. For the purpose of uniformity in the presentation of reports a general plan has been agreed upon by the United States Reclamation Service, the United States Forest Service, the United States Weather Bureau, and the United States Geological Survey, according to which the area of the United States has been divided into twelve parts, whose boundaries coincide with certain natural drainage lines. The areas so described are indicated by the following list of papers on surface water supply for 1909. The dividing line between the North Atlantic and South Atlantic drainage areas lies between York and James rivers.

Papers on surface water supply of the United States, 1909.

Part.	No.	Title.	Part.	No.	Title.
I	261	North Atlantic coast.	VI	266	Missouri River basin.
II	262	South Atlantic coast and eastern Gulf of Mexico.	VII	267	Lower Mississippi River basin.
			VIII	268	Western Gulf of Mexico.
III	263	Ohio River basin.	IX	269	Colorado River basin.
IV	264	St. Lawrence River basin.	X	270	Great Basin.
V	265	Upper Mississippi River and Hudson Bay basin.	XI	271	California.
			XII	272	North Pacific coast.

The following table gives the character of data regarding stream flow at regular stations to be found in the various publications of the United States Geological Survey exclusive of all special papers. Numbers of reports are inclusive and dates also are inclusive so far as the data are available.

Stream-flow data in reports of the United States Geological Survey.

[Ann.—Annual Report; B.—Bulletin; W. S.—Water-Supply Paper.]

Report.	Character of data.	Year.
10th Ann., pt. 2	Descriptive information only	
11th Ann., pt. 2	Monthly discharge	1884 to Sept., 1890.
12th Ann., pt. 2	do	1884 to June 30, 1891.
13th Ann., pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th Ann., pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1888 to Dec. 31, 1893.
B. 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th Ann., pt. 2	Descriptive information only	
B. 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W. S. 11	Gage heights (also gage heights for earlier years)	1896.
18th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for earlier years).	1895 and 1896.
W. S. 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W. S. 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W. S. 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W. S. 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th Ann., pt. 4	Monthly discharge (also for many earlier years)	1898.
W. S. 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.
21st Ann., pt. 4	Monthly discharge	1899.
W. S. 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d Ann., pt. 4	Monthly discharge	1900.
W. S. 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W. S. 75	Monthly discharge	1901.
W. S. 82 to 85	Complete data	1902.
W. S. 97 to 100	do	1903.
W. S. 124 to 135	do	1904.
W. S. 165 to 178	do	1905.
W. S. 201 to 214	Complete data, except descriptions	1906.
W. S. 241 to 252	Complete data	1907–8.
W. S. 261 to 272	do	1909.

NOTE.—No data regarding stream flow are given in the 15th and 17th annual reports.

The records at most of the stations discussed in these reports extend over a series of years. An index of the reports containing records prior to 1904 has been published in Water-Supply Paper 119. The first table which follows gives, by years and drainage basins, the numbers of the papers on surface water supply published from 1899 to 1909. Wherever the data for a drainage basin appear in two papers the number of one is placed in parentheses and the portion of the basin covered by that paper is indicated in the second table. For example, in 1904 the data for Missouri River were published in Water-Supply Papers 130 and 131, and the portion of the records contained in Water-Supply Paper 131, as indicated by the second table, is that relating to Platte and Kansas rivers.

Numbers of water-supply papers containing results of stream measurements, 1899–1909.

	1899.[a]	1900.[b]	1901.	1902.	1903.	1904.	1905.	1906.	1907–8.	1909.
Atlantic coast and eastern Gulf of Mexico:										
New England rivers	35	47	65, 75	82	97	124	165	201	241	261
Hudson River to Delaware River, inclusive	35	47,(48)	65, 75	82	97	125	166	202	241	261
Susquehanna River to York River, inclusive	35	48	65, 75	82	97	126	167	203	241	261
James River to Yadkin River, inclusive	(35).36	48	65, 75	(82),83	(97),98	126	167	203	242	262
Santee River to Pearl River, inclusive	36	48	65, 75	83	98	127	168	204	242	262
St. Lawrence River	36	49	65, 75	(82),83	97	129	170	206	244	264
Hudson Bay			66, 75	85	100	130	171	207	245	265
Mississippi River:										
Ohio River	36	48,(49)	65, 75	83	98	128	169	205	243	263
Upper Mississippi River	36	49	65, 75	83	98,(99)	128, (130)	171	207	245	265
Missouri River	(36),37	49,(50)	66, 75	84	99	130, (131)	172	208	246	266
Lower Mississippi River	37	50	(65), 65, 75	(83),84	(98),99	(128) 131	(169), 173	(205), 209	247	267
Western Gulf of Mexico	37	50	66, 75	84	99	132	174	210	248	268
Pacific coast and Great Basin:										
Colorado River	(37),38	50	66, 75	85	100	133, (134)	175, (177)	211, (213)	249, (251)	269, (271)
Great Basin	38, (39)	51	66, 75	85	100	133, (134)	176, (177)	212, (213)	250, (251)	270, (271)
South Pacific coast to Klamath River, inclusive	(38),39	51	66, 75	85	100	134	177	213	251	271
North Pacific coast	38	51	66, 75	85	100	135	(177), 178	214	252	272

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39.

[b] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52.

Numbers of water-supply papers containing data covering portions of drainage basins.

No.	River basin	Tributaries included.
35	James	
36	Missouri	Gallatin.
37	Colorado	Green, Gunnison, Grand above junction with Gunnison.
38	Sacramento	Except Kings and Kern.
39	Great Basin	Mohave.
48	Delaware	Wissahickon and Schuylkill.
49	Ohio	Scioto.
50	Missouri	Loup and Platte near Columbus, Nebr. All tributaries below junction with Platte.
65	Lower Mississippi	Yazoo.
82	James	
	St. Lawrence	Lake Ontario, tributaries to St. Lawrence River proper.
83	Lower Mississippi	Yazoo.
97	James	
98	Lower Mississippi	Do.
99	Upper Mississippi	Tributaries from the west.
128	Lower Mississippi	Yazoo.
130	Upper Mississippi	Tributaries from the west.
131	Missouri	Platte, Kansas.
134	Colorado	Data near Yuma, Ariz., repeated.
	Great Basin	Susan, Owens, Mohave.
169	Lower Mississippi	Yazoo.
177	Colorado	Below junction with Gila.
	Great Basin	Susan repeated, Owens, Mohave.
	North Pacific coast	Rogue, Umpqua, Siletz.
205	Lower Mississippi	Yazoo, Homochitto.
213	Colorado	Data at Hardyville repeated; at Yuma, Salton Sea.
	Great Basin	Owens, Mohave.
251	Colorado	Yuma and Salton Sea stations repeated.
271	Great Basin	Owens River basin.

The order of treatment of stations in any basin in these papers is downstream. The main stem of any river is determined on the basis of drainage area, local changes in name and lake surface being disregarded. After all stations from the source to the mouth of the main stem of the river have been given, the tributaries are taken up in regular order from source to mouth. The tributaries are treated the same as the main stream, all stations in each tributary basin being given before taking up the next one below.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated above, and in the records for large lakes, where it is often clearer to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups: (1) Those which represent a rate of flow, as second-feet, gallons per minute, miner's inches, and run-off in second-feet per square mile, and (2) those which represent the actual quantity of water, as run-off in depth in inches and acre-feet. They may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second and is the rate of discharge of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed by the use of the factors given in the following table of equivalents.

"Gallons per minute" is generally used in connection with pumping and city water supply.

The "miner's inch" is the rate of discharge of water that passes through an orifice 1 inch square under a head which varies locally. It is commonly used by miners and irrigators throughout the West, and is defined by statute in each State in which it is used.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off, depth in inches on drainage area," is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

"Acre-foot" is equivalent to 43,560 cubic feet, and is the quantity required to cover an acre to the depth of 1 foot. It is commonly used in connection with storage for irrigation work.

CONVENIENT EQUIVALENTS.

The following is a list of convenient equivalents for use in hydraulic computations:

1 second-foot equals 40 California miner's inches (law of March 23, 1901).
1 second-foot equals 38.4 Colorado miner's inches.
1 second-foot equals 40 Arizona miner's inches.
1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,272 gallons for one day.
1 second-foot equals 6.23 British imperial gallons per second.
1 second-foot for one year covers 1 square mile 1.131 feet or 13.572 inches deep.
1 second-foot for one year equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one day covers 1 square mile 0.03719 inch deep.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet.
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 California miner's inches equal 18.7 United States gallons per second.
100 California miner's inches equal 96.0 Colorado miner's inches.
100 California miner's inches for one day equal 4.96 acre-feet.
100 Colorado miner's inches equal 2.60 second-feet.
100 Colorado miner's inches equal 19.5 United States gallons per second.
100 Colorado miner's inches equal 104 California miner's inches.
100 Colorado miner's inches for one day equal 5.17 acre-feet.
100 United States gallons per minute equal 0.223 second-foot.
100 United States gallons per minute for one day equal 0.442 acre-foot.
1,000,000 United States gallons per day equal 1.55 second-feet.
1,000,000 United States gallons equal 3.07 acre-feet.
1,000,000 cubic feet equal 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot equals 7.48 gallons.
1 cubic foot of water weighs 62.5 pounds.
1 cubic meter per minute equals 0.5886 second-foot.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1⅓ horsepower equal about 1 kilowatt.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ = net horsepower on water wheel realizing 80 per cent of theoretical power.

EXPLANATION OF TABLES.

For each drainage basin there is given a brief description of general conditions covering such features as area, source, tributaries, topography, geology, conditions of forestation, rainfall, ice conditions, irrigation, storage, power possibilities, and other special features of importance or interest.

For each regular current-meter gaging station are given in general, and so far as available, the following data: Description of station, list of discharge measurements, table of daily gage heights, table of daily discharges, table of monthly and yearly discharges and run-off. For stations located at weirs or dams the gage-height table is omitted.

In addition to statements regarding the location and installation of current-meter stations the descriptions give information in regard to any conditions which may affect the constancy of the relation of gage height to discharge, covering such points as ice, logging, shifting conditions of flow, and backwater; also information regarding diversions which decrease the total flow at the measuring section. Statements are also made regarding the accuracy and reliability of the data.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, name of hydrographer, width and area of cross section, gage height, and discharge in second-feet.

The table of daily gage heights gives the daily fluctuations of the surface of the river as found from the mean of the gage readings taken each day. At most stations the gage is read in the morning and in the evening. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. All gage heights during ice conditions, backwater from obstructions, etc., are published as recorded, with suitable footnotes. The rating is not applicable for such periods unless the proper corrections to the gage heights are known and applied. Attention is called to the fact that the zero of the gage is placed at an arbitrary datum and has no relation to zero flow or the bottom of the river. In general, the zero is located somewhat below the lowest known flow, so that negative readings shall not occur.

The discharge measurements and gage heights are the base data from which rating tables, daily discharge tables, and monthly discharge tables are computed.

The rating table gives, either directly or by interpolation, the discharge in second-feet corresponding to every stage of the river recorded during the period for which it is applicable. It is not published in this report but can be determined from the daily gage heights and daily discharges for the purposes of verifying the published results as follows.

First plot the discharge measurements for the current and earlier years on cross-section paper with gage heights in feet as ordinates and discharge in second-feet as abscissæ. Then tabulate a number of gage heights taken from the daily gage-height table for the complete range of stage given and the corresponding discharges for the days selected from the daily discharge table and plot the values on cross-section paper. The last points plotted will define the rating curve used and will lie among the plotted discharge measurements. After drawing the rating curve, a table can be developed by scaling off the discharge in second-feet for each tenth foot of gage height. These values should be so adjusted that the first differences shall always be increasing or constant, except for known backwater conditions.

The table of daily discharges gives the discharges in second-feet corresponding to the observed gage heights as determined from the rating tables.

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge consequently larger than given in the "Maximum" column. Likewise, in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet for each second during the month. On this the computations for the remaining columns, which are defined on page 13, are based.

FIELD METHODS OF MEASURING STREAM FLOW.

There are three distinct methods of determining the flow of open-channel streams: (1) By measurements of slope and cross section and the use of Chezy's and Kutter's formulas; (2) by means of a weir or dam; (3) by measurements of the velocity of the current and of the area of the cross section. The method chosen depends on the local physical conditions, the degree of accuracy desired, the funds available, and the length of time that the record is to be continued.

Slope method.—Much information has been collected relative to the coefficients to be used in the Chezy formula, $v=c\sqrt{Rs}$. This has been utilized by Kutter, both in developing his formula for c and in determining the values of the coefficient n which appear therein. The results obtained by the slope method are in general only roughly approximate, owing to the difficulty in obtaining accurate data and the uncertainty of the value for n to be used in Kutter's formula. The most common use of this method is in estimating the flood discharge of a stream when the only data available are the cross section, the slope as shown by marks along the bank, and a knowledge of the general conditions. It is seldom used by the United States Geological Survey.[a]

Weir method.—Relatively few stations are maintained at weirs or dams by the United States Geological Survey. Standard types of sharp-crested and broad-crested weirs within the limits for which accurate coefficients have been experimentally obtained give very accurate records of discharge if properly maintained. At practically all broad-crested weirs, however, there is a diversion of water either through or around the dam, usually for the purpose of development of water power. The flow is often complicated and the records are subject to errors from such sources as leakage through the dam, backwater at high stages, uncertainty regarding coefficient, irregularity of crest, obstructions from logs or ice, use of flashboards, old turbines with imperfect ratings, and many others depending on the type of development and the uses of the diverted water.

In general records of discharge at dams are usually accurate enough for practical use if no others are available. It has been the general experience of the United States Geological Survey, however, that records at current-meter gaging stations under unobstructed channel conditions are more accurate than those collected at dams, and where the conditions are reasonably favorable are practically as good as those obtained at sharp-crested weirs.[b]

Velocity method.—Streams in general present throughout their courses to a greater or less extent all conditions of permanent, semipermanent, and varying conditions of flow. In accordance with the location of the measuring section with respect to these physical conditions, current-meter gaging stations may in general be divided into four classes—(1) those with permanent conditions of flow; (2) those with beds which change only during extreme high water; (3) those with beds which change frequently, but which do not cause a variation of more than about 5 per cent of the discharge curves from year to year; and (4) those with constantly shifting beds. In determining the daily flow different office methods are necessary for each class. The field data on which the determinations are based and the methods of collecting them are, however, in general the same.

Great care is taken in the selection and equipment of gaging stations for determining discharge by velocity measurements, in order that the data may have the required degree of accuracy. They are located, as far as possible, at such points that the relation between gage height and discharge will always remain constant for any given stage. The experience of engineers of the Geological Survey has been that permanency of conditions of flow is the prime requisite of any current-meter gaging station when maintained for several years unless funds are available to cover all changes in conditions of flow. A straight, smooth section without cross currents, backwater, boils, etc., at any stage is highly desirable, but on most streams is not attainable except at the cost of a cable equipment. Rough, permanent sections, if measurements are properly made by experienced engineers, taking measuring points at a distance apart of 5 per cent or less of the total width, will, within reasonable limits, yield better results for a given outlay of money than semipermanent or shifting sections with smooth, uniform current. So far as possible stations are located where the banks are high and not subject to overflow at high stages and out of the influence of tributary streams, dams, or other artificial obstructions which might affect the relation between gage height and discharge.

---

[a] Full information regarding this method is given in text-books on hydraulics.

[b] The determination of discharge over the different types of weirs and dams is treated fully in "Weir experiments, coefficients, and formulas" (Water-Supply Paper 200) and in the various textbooks on hydraulics. "Turbine water-wheel tests and power tables" (Water-Supply Paper 180) treats of the discharge through turbines when used as meters. The edition of the latter water-supply paper is nearly exhausted. It can, however, be consulted at most of the larger libraries of the country or it can be obtained from the superintendent of documents, Washington, D. C., at a cost of 20 cents.

A gaging station consists essentially of a gage for determining the daily fluctuations of stage of the river and some structure or apparatus from which discharge measurements are made, usually a bridge or cable.

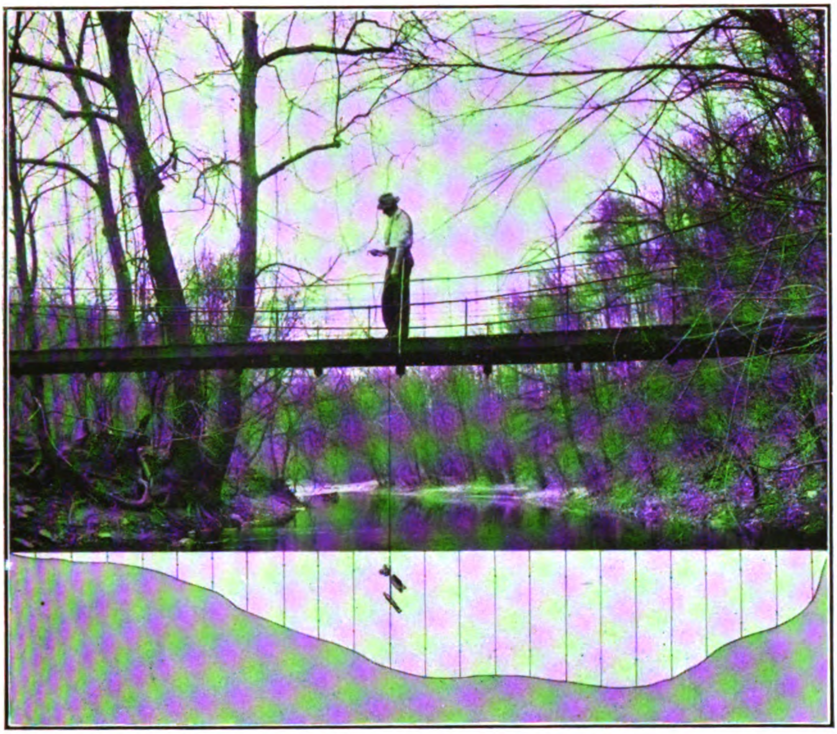
The two factors required to determine the discharge of a stream past a section perpendicular to the mean direction of the current are the area of the cross section and the mean velocity of flow normal to that section.

In making a measurement with a current meter a number of points, called measuring points, are measured off above and in the plane of the measuring section at which observations of depth and velocity are taken. (See Pl. I, *A*.) These points are spaced equally for those parts of the section where the flow is uniform and smooth and are spaced unequally for other parts according to the discretion and judgment of the engineer. In general the points should not be spaced farther apart than 5 per cent of the channel width, nor farther apart than the approximate mean depth of the section at the time of measurement.

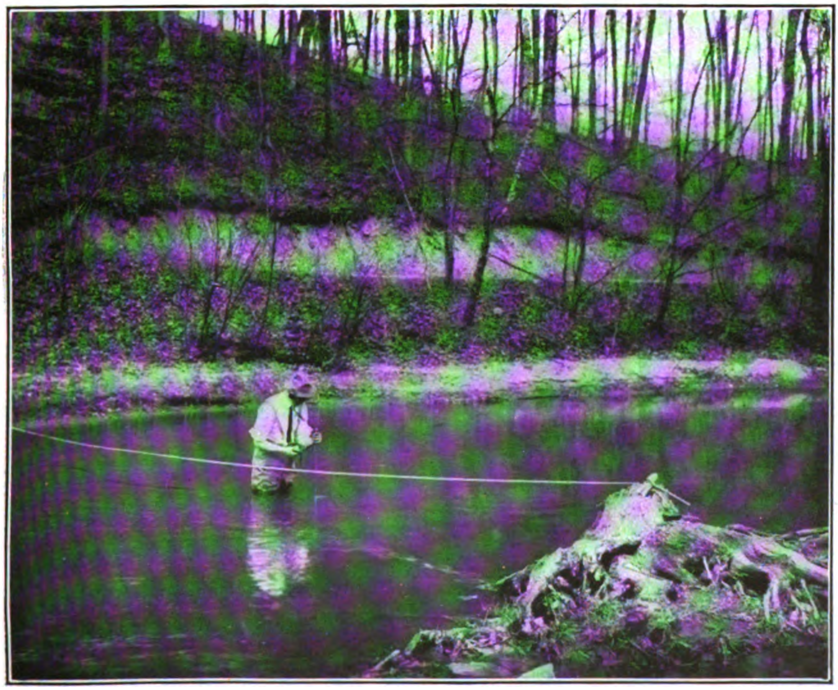
The measuring points divide the total cross section into elementary strips at each end of which observations of depth and velocity are made. The discharge of any elementary strip is the product of the average of the depths at the two ends times the width of the strip times the average of the mean velocities at the two ends of the strip. The sum of the discharges of the elementary strips is the total discharge of the stream.[a]

---

[a] For a discussion of methods of computing the discharge of a stream see Engineering News, June 25, 1908.



A. FOR BRIDGE MEASUREMENT.



B. FOR WADING MEASUREMENT.

TYPICAL GAGING STATIONS.

Depths for the determination of the area are usually obtained by sounding with the current meter and cable. In rough sections or swift current an ordinary weight and cable are used, particular care being taken that all observations shall be in the plane of the cross section.

Two methods of determining the velocity of flow of a stream are in general use—the float method and the current-meter mothod.

The float method, with its various modifications of surface, subsurface, and tube or rod floats, is now considered obsolete in the ordinary practice of the United States Geological Survey. The use of this method is limited to special conditions where it is impracticable to use the current meter, such as in places where large quantities of ice or débris which may damage the meter are flowing with the current, and for miscellaneous measurements or other work where a high degree of accuracy is not necessary. Tube floats are very satisfactory for use in canals with regular bottoms and even flow of current. Measurements by the float method are made as follows: The velocity of flow of the stream is obtained by observing the time which it takes floats set free at different points across the stream to pass between two range lines about 200 feet apart. The area used is the mean value obtained from several cross sectioms neasured between the two range lines. The chief disadvantages of this method are difficulty in obtaining the correct value of mean area for the course used and uncertainty regarding the proper coefficient to apply to the observed velocity.[a]

The Price current meter is now used almost to the exclusion of other types of meters by the United States Geological Survey in the determination of the velocity of flow of water in open channels, a use for which it is adapted under practically all conditions.[b]

Plate II shows in the center the new type of penta-recording current meter equipped for measurements at bridge and cable stations; on the left the same type of meter is shown equipped for wading measurements, to record by the acoustic method; on the right the meter is shown equipped to record electrically. (See Pl. I, *B*.) Briefly, the meter consists of six cups attached to a vertical shaft which revolves on a conical hardened steel point when immersed in moving water. The revolutions are indicated electrically. The rating, or relation between the velocity of moving water and the revolutions of the wheel, is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity per second of moving water for any number of revolutions in a given time interval. The ratio of revolutions per second to velocity of flow in feet per second is very nearly a constant for all speeds and is approximately 0.45.

---

[a] Further information regarding the float method is given in Water-Supply Paper 95 and the various textbooks on stream flow.

[b] See Hoyt, J. C., and others, Use and care of the current meter as practiced by the U. S. Geological Survey: Trans. Am. Soc. Civil Eng., vol. 66, 1910, p. 70.

Three classes of methods of measuring velocity with current meters are in general use—multiple-point, single-point, and integration.

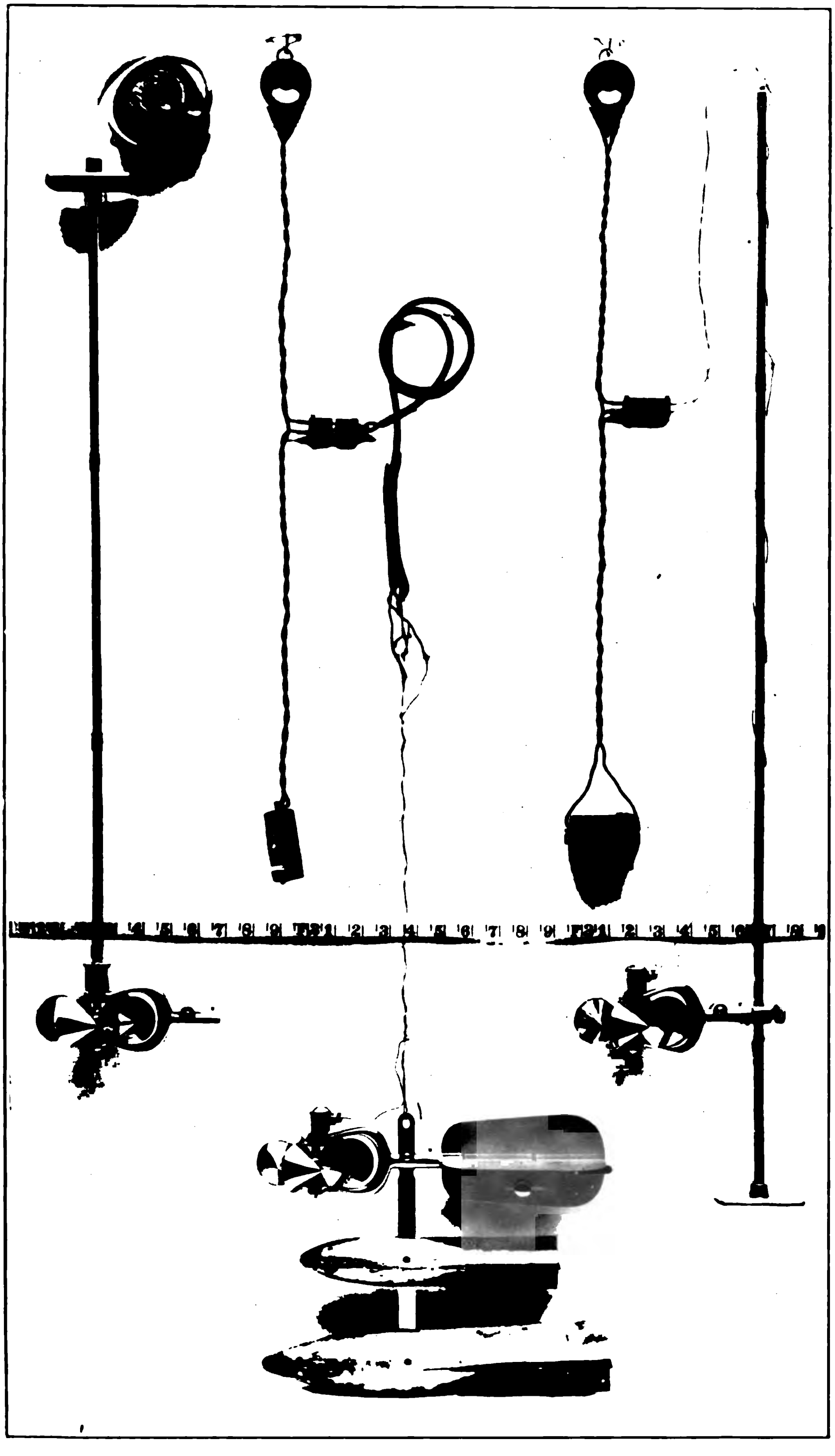
The two principal multiple-point methods in general use are the vertical velocity curve and 0.2 and 0.8 depth.

In the vertical velocity curve method a series of velocity determinations is made in each vertical at regular intervals, usually about 10 to 20 per cent of the depth apart. By plotting these velocities as abscissas and their depths as ordinates and drawing a smooth curve among the resulting points, the vertical velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. This method of obtaining the mean velocity in the vertical is probably the best known, but on account of the length of time required to make a complete measurement its use is largely limited to the determination of coefficients for purposes of comparison and to measurements under ice.

In the second multiple-point method the meter is held successively at 0.2 and 0.8 depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. (See Pl. I, *A*.) On the assumption that the vertical velocity curve is a common parabola with horizontal axis, the mean of the velocities at 0.22 and 0.79 depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this multiple-point method gives the mean velocity very closely for open-water conditions and that in a completed measurement it seldom varies as much as 1 per cent from the value given by the vertical velocity curve method. Moreover, the indications are that it holds nearly as well for ice-covered rivers. It is very extensively used in the regular practice of the United States Geological Survey.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined or must be assumed.

Extensive experiments by means of vertical velocity curves show that the thread of mean velocity generally occurs between 0.5 and 0.7 total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and at this point the meter is held in most of the measurements made by the single-point method. A large number of vertical velocity curve measurements, taken on many streams and under varying conditions, show that the average



SMALL PRICE CURRENT METERS.

coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity. The variation of the coefficient from unity in individual cases is, however, greater than in the 0.2 and 0.8 method and the general results are not as satisfactory.

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the effect of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocity taken at the subsurface to the mean has been found to be in general from about 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is especially adapted for flood measurements, or when the velocity is so great that the meter can not be kept in the correct position for the other methods.

The vertical integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface and noting the number of revolutions and the time taken in the operation. This method has the advantage that the velocity at each point of the vertical is measured twice. It is useful as a check on the point methods. In using the Price meter great care should be taken that the vertical movement of the meter is not rapid enough to vitiate the accuracy of the resulting velocity.

The determination of the flow of an ice-covered stream is difficult, owing to diversity and instability of conditions during the winter period and also to lack of definite information in regard to the laws of flow of water under ice. The method now employed is to make frequent discharge measurements during the frozen periods by the 0.2 and 0.8 and the vertical velocity curve methods, and to keep an accurate record of the conditions, such as the gage height to the surface of the water as it rises in a hole cut in the ice, and the thickness and character of the ice. From these data an approximate estimate of the daily flow can be made by constructing a rating curve (really a series of curves) similar to that used for open channels, but considering, in addition to gage heights and discharge, the varying thickness of ice.[a]

OFFICE METHODS OF COMPUTING AND STUDYING DISCHARGE AND RUN-OFF.

At the end of each year the field or base data for current-meter gaging stations, consisting of daily gage heights, discharge measurements, and full notes, are assembled. The measurements are plotted on cross-section paper and rating curves are drawn wherever feasible. The rating tables prepared from these curves are then applied to the tables of daily gage heights to obtain the daily discharges, and from these applications the tables of monthly discharge and run-off are computed.

---

[a] For information in regard to flow under ice cover see Water-Supply Paper U.S. Geol. Survey No. 187.

Rating curves are drawn and studied with special reference to the class of channel conditions which they represent. (See p. 17.) The discharge measurements for all classes of stations when plotted with gage heights in feet as ordinates and discharges in second-feet as abscissas define rating curves which are generally more or less parabolic in form. In many cases curves of area in square feet and mean velocity in feet per second are also constructed to the same scale of ordinates as the discharge curve. These are used mainly to extend the discharge curves beyond the limits of the plotted discharge measurements, and for checking purposes to avoid errors in the form of the discharge curve and to determine and eliminate erroneous measurements.

For every rating table the following assumptions are made for the period of application of the table: (*a*) That the discharge is a function of and increases gradually with the stage; (*b*) that the discharge is the same whenever the stream is at a given stage, and hence such changes in conditions of flow as may have occurred during the period of application are either compensating or negligible, except that the rating is not applicable for known conditions of ice, log jams, or other similar obstructions; (*c*) that the increased and decreased discharge due to change of slope on rising and falling stages is either negligible or compensating.

As already stated, the gaging stations may be divided into several classes, as indicated in the following paragraphs:

The stations of class 1 represent the most favorable conditions for an accurate rating and are also the most economical to maintain. The bed of the stream is usually composed of rock, and is not subject to the deposit of sediment and loose material. This class includes also many stations located in a pool below which is a permanent rocky riffle that controls the flow like a weir. Provided the control is sufficiently high and close to the gage to prevent cut and fill at the gaging point from materially affecting the slope of the water surface, the gage height will for all practical purposes be a true index of the discharge. Discharge measurements made at such stations usually plot within 2 or 3 per cent of the mean-discharge curve, and the rating developed from that curve represents a very high degree of accuracy. For examples of this class see stations of the north Atlantic coast drainage basins.

Class 2 is confined mainly to stations on rough, mountainous streams with steep slopes. The beds of such streams are as a rule comparatively permanent during low and medium stages, and when the flow is sufficiently well defined by an adequate number of discharge measurements before and after each flood the stations of this class give nearly as good results as those of class 1. As it is seldom possible to make measurements covering the time of change at flood stage, the assumption is often made that the curves before and after the flood converged to a common point at the highest gage height recorded during the flood. Hence the only uncertain period occurs during the few days of highest gage heights covering the period of actual change in conditions of flow. For examples of this class see stations in the upper Missouri River basin.

Class 3 includes most of the current-meter gaging stations maintained by the United States Geological Survey. If sufficient measurements could be made at stations of this class, results would be obtained nearly equaling those of class 1, but owing to the limited funds at the disposal of the Survey this is manifestly impossible, nor is it necessary for the uses to which discharge data are applied. The critical points are, as a rule, at relatively high or low stages. The percentage error, however, is greater at low stages. No absolute rule can be laid down for stations of this class. Each rating curve must be constructed mainly on the basis of the measurements of the current year, the engineer being guided largely by the past history of the station and the following general law: If all measurements ever made at a station of this class are plotted on cross-section paper, they will define a mean curve which may be called a standard curve. It has been found in practice that if after a change caused by high stage a relatively constant condition of flow occurs at medium and low stages, all measurements made after the change will plot on a smooth curve which is practically parallel to the standard curve with respect to ordinates or gage heights. This law of the parallelism of ratings is the fundamental basis of all ratings and estimates at stations with semipermanent and shifting channels. It is not absolutely correct, but, with few exceptions, answers all the practical requirements of estimates made at low and medium stages after a change at a high stage. This law appears to hold equally true whether the change occurs at the measuring section or at some controlling point below. The change is, of course, fundamentally due to change in the channel caused by cut or fill, or both, at or near the measuring section. For all except small streams the changes in section usually occur at the bottom. The following simple but typical examples illustrate this law:

(*a*) If 0.5 foot of planking were to be nailed on the bottom of a well-rated wooden flume of rectangular section, there would result, other conditions of flow being equal, new curves of discharge, area, and velocity, each plotting 0.5 foot above the original curves when referred to the original gage. In other words, this condition would be analogous to a uniform fill or cut in a river channel which either reduces or increases all three values of discharge, area, and velocity for any gage height. In practice, however, such ideal conditions rarely exist.

(*b*) In the case of a cut or fill at the measuring section, there is a marked tendency toward decrease or increase, respectively, of the velocity. In other words, the velocity has a compensating effect, and if the compensation is exact at all stages the discharge at a given stage will be the same under both the new and the old conditions.

(*c*) In the case of uniform change along the crest of a weir or rocky control, the area curve will remain the same as before the change, and it can be shown that here again the change in velocity curve is such that it will produce a new discharge curve essentially parallel to the original discharge curve with respect to their ordinates.

Of course in actual practice such simple changes of section do not occur. The changes are complicated and lack uniformity, a cut at one place being largely offset by a fill at another, and vice versa. If these changes are very radical and involve large percentages of the total area—as, for example, on small streams—there may result a wide departure from the law of parallelism of ratings. In complicated changes of section the corresponding changes in velocity which tend to produce a new parallel discharge curve may interfere with each other materially, causing eddies, boils, backwater, and radical changes in slope. In such extreme conditions, however, the measuring section would more properly fall under class 4 and would require very frequent measurements of discharge. Special stress is laid on the fact that in the lack of other data to the contrary the utilization of this law will yield the most probable results.

Slight changes at low or medium stages of an oscillating character are usually averaged by a mean curve drawn among them parallel to the standard curve, and if the individual measurements do not vary more than 5 per cent from the rating curve the results are considered good for stations of this class.

For examples of stations of this class see stations of the south Atlantic coast and eastern Gulf of Mexico drainage basins.

Class 4 comprises stations that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency varying from a measurement every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow. The following graphic method of determining the daily discharge of streams of this class is now used by the engineers of the United States Geological Survey almost exclusively, owing to the rapidity with which the computations can be made, the clearness with which changes in conditions of flow can be followed, and the accuracy of the results obtained.

In the graphic method of determining the daily discharge of streams with changeable beds, which was devised by R. H. Bolster, the discharge measurements for the entire year are first plotted with discharges as abscissas and gage heights as ordinates. The points so plotted are considered chronologically and, even though scattered, will usually locate one or more fairly well-defined curves, called standard curves. (See fig. 1.) In general the number and position of these standard curves is determined by the radical changes in the stream bed due to floods.

When stream beds change very rapidly it is necessary to change the position of the rating curve daily, making a new curve for each day. This daily curve is of the same form as the standard curve and is parallel to it with respect to ordinates. The rating curve for a day when a measurement is made passes through such plotted measurement, the discharge for that day being read off from the scale of discharge in second-feet, at the point of intersection of the curve and the mean gage height for the day. In order to locate the rating curve for other days, lines are drawn connecting consecutive measurements. These lines are called correction curves and should have the same curvature as that portion of the standard curve which lies vertically above or below them. These lines are divided into as many equal parts as there are days intervening between the measurements, on the assumption that the change in conditions of flow between any two consecutive measurements is uniform from day to day. The daily rating curve will then pass through these points of division, and the discharge is read directly from these curves at their point of intersection with the observed daily gage heights.

To facilitate the use of the method and obviate the use of daily rating curves, and to make it as rapid in application as the common method for permanent stations, the standard curve or curves, together with a vertical line of reference, should be transferred from the original station sheet to tracing cloth, which can be readily shifted vertically to any desired position by always keeping the two vertical reference lines in coincidence. Thus the daily rating curve, which is merely the standard curve transferred, can be placed in any desired position.

Another way of simplifying the work of applying this method is to use dividers. Always keep one point of the dividers coincident with the standard curve and always keep both points on the same vertical line of discharge. By spreading the points, the point which is not coincident with the standard curve can be made to trace any daily rating curve desired.

In applying and modifying this method, judgment must be used for long-time intervals of no measurements or for radical changes in the stream bed caused by sudden floods. The following tables and figure 1 illustrate the Bolster or graphic method of obtaining daily discharge:

List of measurements to illustrate graphic method of determining daily discharge.

No.	Date.	Gage height.	Discharge.	No.	Date.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
1	June 1	2.55	3,700	6	July 18	3.8	6,460
2	June 6	.55	500	7	July 20	2.2	2,330
3	June 14	1.4	1,200	8	July 22	.4	200
4	June 22	1.2	600	9	July 31	.9	150
5	July 2	1.5	500				

Daily gage heights and discharges to illustrate graphic method of determining daily discharge.

Day.	June.		July.		Day.	June.		July.	
	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1	3.0	4,870	1.5	530	16	1.1	760	3.5	5,370
2	2.5	3,580	1.5	500	17	1.0	620	3.2	4,610
3	2.0	2,490	1.5	570	18	1.0	580	3.7	6,150
4	1.5	1,610	1.6	730	19	1.1	640	4.0	7,080
5	1.0	930	1.6	780	20	1.2	690	3.0	4,160
6	.4	390	1.8	1,050	21	1.2	650	1.8	1,640
7	.6	510	1.7	970	22	1.3	690	.8	480
8	.6	490	1.7	1,020	23	1.5	850	.3	120
9	.7	550	1.9	1,320	24	1.8	1,170	.3	100
10	.8	620	2.0	1,510	25	1.7	990	.4	110
11	1.0	800	2.2	1,890	26	1.6	830	.4	90
12	1.5	1,400	2.6	2,720	27	1.6	780	.6	130
13	1.4	1,240	3.0	3,700	28	1.6	740	.7	150
14	1.4	1,200	3.6	5,440	29	1.6	700	.8	170
15	1.3	1,020	3.7	5,850	30	1.6	660	.9	180
					31	....	....	1.0	200

The computations have, as a rule, been carried to three significant figures. Computation machines, Crelle's tables, and the 20-inch slide rule have been generally used. All computations are carefully checked.

After the computations have been completed they are entered in tables and carefully studied and intercompared to eliminate or account for all gross errors so far as possible. Missing periods are filled in, so far as feasible, by means of comparison with adjacent streams. The attempt is made to complete years or periods of discharge, thus eliminating fragmentary and disjointed records. Full notes accompanying such estimates follow the monthly discharge tables.

For most of the northern stations estimates have been made of the monthly discharge during frozen periods. These are based on measurements under ice conditions whenever available, daily records of temperature and precipitation obtained from the United States Weather Bureau climate and crop reports, observers' notes of con-

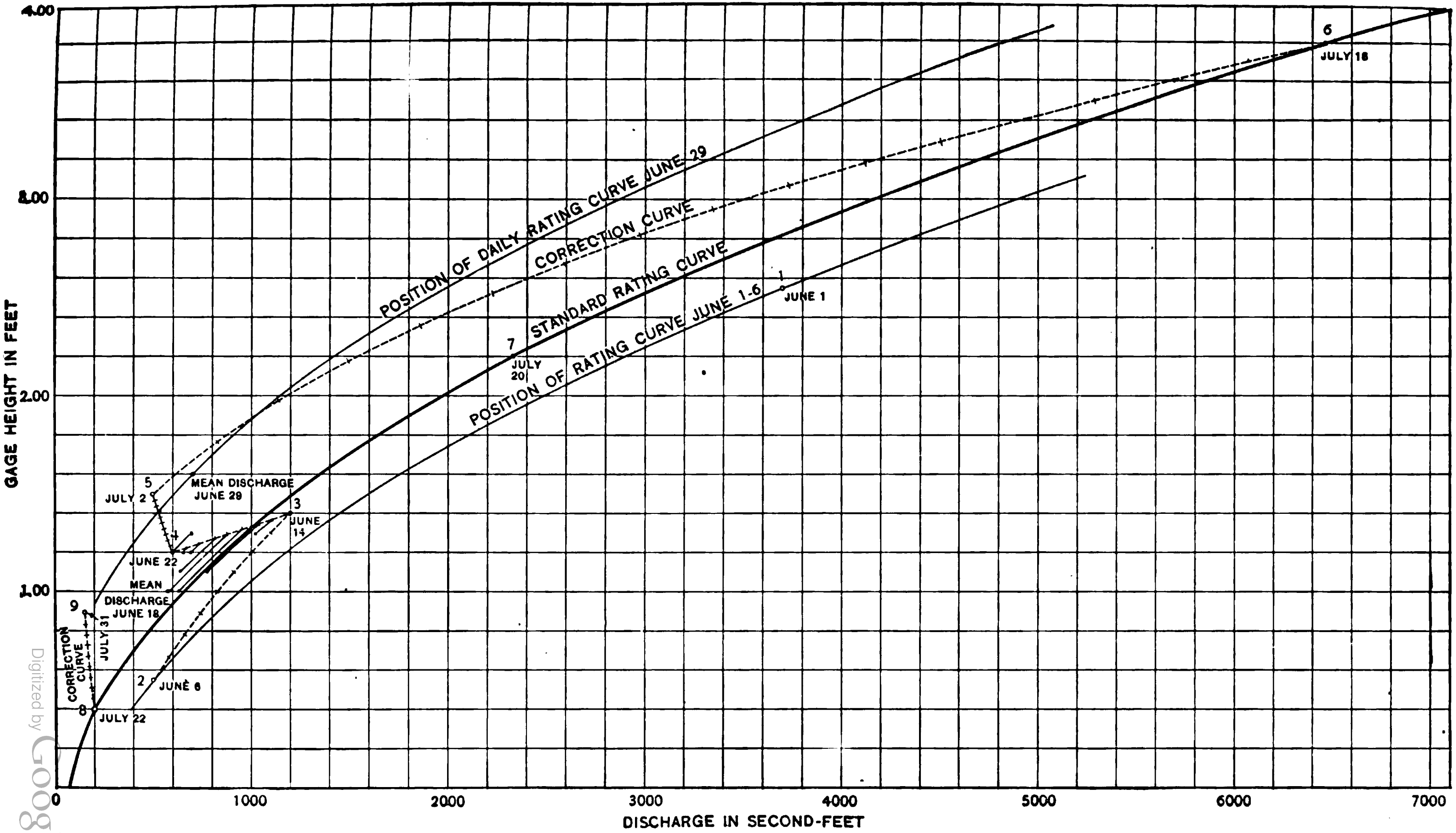


FIGURE 1.—Graphic method of determining daily discharge of streams with changeable beds.

ditions, and a careful and thorough intercomparison of results with adjacent streams. Although every care possible is used in making these estimates, they are often very rough, the data for some of them being so poor that the estimates are liable to as much as 25 to 50 per cent error. It is believed, however, that estimates of this character are better than none at all, and serve the purpose of indicating in a relative way the proportionate amount of flow during the frozen period. These estimates are, as a rule, included in the annual discharge. The large error of the individual months has a relatively small effect on the annual total, and it is for many purposes desirable to have the yearly discharge computed even though some error is involved in doing so.

ACCURACY AND RELIABILITY OF FIELD DATA AND COMPARATIVE RESULTS.

Practically all discharge measurements made under fair conditions are well within 5 per cent of the true discharge at the time of observation. Inasmuch as the errors of meter measurements are largely compensating, the mean rating curve, when well defined, is much more accurate than the individual measurements. Numerous tests and experiments have been made to test the accuracy of current-meter work. These show that it compares very favorably with the results from standard weirs, and, owing to simplicity of methods, usually give results that are much more reliable than those from stations at dams, where uncertainty regarding the coefficient and complicated conditions of flow prevail.

The work is, of course, dependent on the reliability of the observers. With relatively few exceptions, the observers perform their work honestly. Care is taken, however, to watch them closely and to inquire into any discrepancies. It is, of course, obvious that one gage reading a day does not always give the mean height for that day. As an almost invariable rule, however, errors from this source are compensating and virtually negligible in a period of one month, although a single day's reading may, when taken by itself, be considerably in error.

The effort is made to visit every station at least once each year for the purpose of making a measurement to determine the constancy of conditions of flow since the last measurement made during the preceding year, and also to check the elevation of the gage. On account of lack of funds or for other causes, some stations were not visited during the current year. If conditions of flow have been reasonably permanent up to the time of the last preceding measurement, it is considered best to publish values of discharge on the basis of the latest verified rating curve rather than to omit them altogether, although it should be distinctly understood that such records are at times subject to considerable error. This is also true, although to a less degree, of the period of records since the date of the last measurement of the current year. As a rule the accuracy notes are based on the assumption that the rating curve used is strictly applicable to the current year.

In order to give engineers and others information regarding the probable accuracy of the computed results, footnotes are added to the daily discharge tables, stating the probable accuracy of the rating tables used, and an accuracy column in inserted in the monthly discharge table. For the rating tables "well defined" indicates in general that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined" or "approximate," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The accuracy column in the monthly discharge table does not apply to the maximum or minimum nor to any individual day, but to the monthly mean. It is based on the accuracy of the rating, the probable reliability of the observer, and knowledge of local conditions. In this column, A indicates that the mean monthly flow is probably accurate within 5 per cent; B, within 10 per cent; C, within 15 per cent; D, within 25 per cent. Special conditions are covered by footnotes.

USE OF THE DATA.

In general the policy is followed of making available for the public the base data which are collected in the field each year by the survey engineers. This is done to comply with the law, but also for the express purpose of giving to any engineer the opportunity of examining the computed results and of changing and adjusting them as may seem best to him. Although it is believed that the rating tables and computed monthly discharges are as good as the base data up to and including the current year will warrant, it should always be borne in mind that the additional data collected at each station from year to year nearly always throw new light on data already collected and published, and hence allow more or less improvement in the computed results of earlier years. It is therefore expected that the engineer who makes serious use of the data given in these papers will verify all ratings and make such adjustments in earlier years as may seem necessary. The work of compiling, studying, revising, and republishing data for different drainage basins for five or ten year periods or more is carried on by the United States Geological Survey so far as the funds for such work are available.

The values in the table of monthly discharge are so arranged as to give only a general idea of the conditions of flow at the station, and it is not expected that they will be used for other than preliminary estimates.

The daily discharges are published to allow a more detailed study of the variation in flow and to determine the periods of deficient flow.

COOPERATIVE DATA.

Cooperative data of various kinds and also data regarding the run-off at many stations maintained wholly by private funds are incorporated in the surface water-supply reports of the United States Geological Survey.

Many stations throughout the country are maintained for specific purposes by private parties who supply the records gratuitously to the United States Geological Survey for publication. When such records are supplied by responsible parties and appear to be reasonably accurate they are verified, so far as possible, and estimated values of accuracy are given. Records clearly known to be worthless or misleading are not published. As it is, however, impossible to completely verify all such records furnished—because of lack of funds or for other causes—they are published for what they are worth, as they are of value as a matter of record and afford at least approximate information regarding stream flow at the particular localities. The Survey does not, however, assume any responsibility for inaccuracies found in such records, although most of them are believed to be reasonably good.

COOPERATION AND ACKNOWLEDGMENTS.

Special acknowledgments are due the following parties for cooperative assistance:

The State engineer of Colorado, Charles W. Comstock, paid the expenses of the hydrographers and the salaries of the observers at a number of stations in this drainage basin. He has also assisted in the work in other ways and has furnished some data which he procured independently for publication in this paper.

The Territorial engineer of New Mexico, Vernon T. Sullivan, has taken special interest in cooperative work and has borne more than half the expense of the New Mexico work from the $2,500 appropriated by the legislature for the whole Territory and from other funds pertaining to his office.

The Atchison, Topeka & Santa Fe Railway Company donated $1,000 to New Mexico, to be spent in cooperation with the United States Geological Survey in the Territory during 1909.

Prof. George J. Lyon, of Colorado College, furnished his services as hydrographer gratis for a number of weeks during the year.

The Tallahatchie drainage commission bore the expense of gage observers in the Yazoo River drainage basin, also for a part of the discharge measurements.

The State geologist of Arkansas, A. H. Purdue, maintained several stations in the White River drainage basin, the results being published by the United States Geological Survey.

Thanks are also due to the United States Weather Bureau, the A. L. Register Co., R. F. Proctor, F. H. Whiting, A. A. Weiland, and all other persons and companies who have rendered assistance.

DIVISION OF WORK.

The field data in the Arkansas River drainage basin were collected under the direction of W. B. Freeman, district engineer, by J. B. Stewart, G. H. Russell, and George F. Lyon.

The field data in the Canadian River drainage basin were collected under the general direction of W. B. Freeman, district engineer, by J. B. Stewart, but under the more immediate supervision of Vernon T. Sullivan, territorial engineer, by C. D. Miller and W. H. Sutton.

The field data for the Yazoo River drainage basin were collected under the direction of M. R. Hall, district engineer, by W. A. Lamb and E. H. Swett.

The field data in the White River drainage basin were collected under the direction of A. H. Horton, district engineer, by W. N. Gladson.

The ratings were made by W. B. Freeman, M. R. Hall, and R. H. Bolster. The computations were made and the completed data prepared for publication under the direction of R. H. Bolster, assistant engineer, by G. C. Stevens, R. C. Rice, J. G. Mathers, M. I. Walters, M. E. McChristie, and L. T. King. The manuscript was edited by Mrs. B. D. Wood.

GAGING STATIONS MAINTAINED IN THE LOWER MISSISSIPPI RIVER BASIN.

The following is a list of gaging stations maintained in the lower Mississippi River drainage basin by the United States Geological Survey and cooperative parties. The stations are arranged by river basins, in downstream order, as explained on page 11, tributaries being indicated by indention. Data for these stations have been published in the reports listed on page 9.

MERAMEC RIVER BASIN.

- Meramec River near Meramec, Mo., 1903–1906.
- Meramec River near Eureka, Mo., 1903–1906.
- Meramec River (Station No. 1) at Fenton, Mo., 1903.
- Meramec River (Station No. 2) below Fenton, Mo., 1903.
  - Meramec Spring near Meramec, Mo., 1903–1906.
  - Courtois Creek at Scotia, Mo., 1905–6.

WHITE RIVER BASIN.

White River at Beaver, Ark., 1909.
White River near Branson, Mo., 1909.
White River near Lead Hill, Ark., 1909.
White River near Cotter, Ark., 1909.
White River at Walls Ferry, Ark., 1909.
  Buffalo River near Gilbert, Ark., 1909.
  North Fork River near Henderson, Ark., 1909.
  Greer Spring at Greer, Mo., 1904.
  Little Red River near Pangburn, Ark., 1909.

ARKANSAS RIVER BASIN.

Arkansas River near Granite, Colo., 1895, 1897–1899, 1901.
Arkansas River near Salida, Colo., 1895–1903.
Arkansas River at Canon City, Colo., 1888–1909.
Arkansas River near Rock Canyon, Colo., 1889.
Arkansas River above Pueblo, Colo., 1885–1887.
Arkansas River at Pueblo, Colo., 1894–1909.
Arkansas River near Nepesta, Colo., 1897–1903.
Arkansas River near Manzanola, Colo., 1898.
Arkansas River near Rocky Ford, Colo., 1897–1903.
Arkansas River at La Junta, Colo., 1889, 1893–1895, 1903, 1908.
Arkansas River near Las Animas, Colo., 1898.
Arkansas River near Prowers, Colo., 1900, 1901, 1903.
Arkansas River near Amity canal head-gates, Colo., 1898–99.
Arkansas River near Granada, 1898–1901, 1904.
Arkansas River near Barton (Byron), Colo., 1893–94, 1901–2.
Arkansas River at Holly, Colo., 1907–1909.
Arkansas River near Syracuse, Kans., 1903–1906.
Arkansas River near Coolidge, Kans., 1903.
Arkansas River near Dodge, Kans., 1902–1906.
Arkansas River near Hutchinson, Kans., 1895–1905.
Arkansas River near Arkansas City, Kans., 1902–1906.
  Arkansas River, East Fork, near Leadville, Colo., 1890, 1903.
  Arkansas River, Tennessee Fork, near Leadville, Colo., 1890, 1903.
  Arkansas River, Lake Fork, near Arkansas Junction, Colo., 1903.
  Arkansas River, Lake Fork, near Leadville, Colo., 1890.
  Lake Creek near Twin Lakes, Colo., 1899–1900.
  Clear Creek near Granite, Colo., 1890.
  Cottonwood Creek:
    Cottonwood Creek, Middle Fork, near Buena Vista, Colo., 1890.
    Cottonwood Creek, South Fork, near Buena Vista, Colo., 1890.
  Grape Creek near Canon City, Colo., 1907–1909.
  Huerfano River near Undercliffe, Colo., 1908.
    Cucharas River at Walsenburg, Colo., 1907–8.
  Purgatory River at Trinidad, Colo., 1896–1899, 1905–1909.
  Purgatory River near Canon Entrance (Alfalfa), Colo., 1905–1907.
  Purgatory River near J. J. ranch, Colo., 1898.
  Purgatory River near Las Animas, Colo., 1889.
  Walnut River near Arkansas City, Kans., 1902–3.
  Arkansas River, Salt Fork, near Alva, Okla., 1904–5.
  Arkansas River, Salt Fork, near Tonkawa, Okla., 1903–5.
    Medicine River near Kiowa, Kans., 1895–96.

- Cimarron River near Arkalon, Kans., 1895–96, 1903–1905.
- Cimarron River near Kenton, Okla., 1904–5.
- Cimarron River near Garrett, Okla., 1905–1907.
- Cimarron River near Waynoka, Okla., 1903–1905.
- Verdigris River near Independence, Kans., 1904.
- Verdigris River near Liberty, Kans., 1895–1903.
- Verdigris River near Catoosa, Okla., 1903–1905.
  - Fall River near Fall River, Kans., 1904–5.
- Neosho River near Neosho Rapids, Kans., 1904.
- Neosho River near Iola, Kans., 1895–1903.
- Neosho River near Humboldt, Kans., 1904.
- Neosho River (or Grand River) near Fort Gibson, Okla., 1899, 1903–1905.
- Canadian River near Logan, N. Mex., 1905, 1909.
- Canadian River at Calvin, Okla., 1904–1908.
  - Cimarron River at Ute Park, N. Mex., 1907–1909.
  - Cimarron River at Springer, N. Mex., 1907–1909.
    - Rayado River near Rayado, N. Mex., 1909.
    - Rayado River near Springer, N. Mex., 1907–1909.
  - Mora River at La Cueva, N. Mex., 1903–1908.
  - Mora River near Weber, N. Mex., 1903–4.
  - Mora River near Watrous, N. Mex., 1894–1896.
    - Sapello River at Sapello, N. Mex., 1903–4.
    - Sapello River at Los Alamos, N. Mex., 1903–1908.
      - Sapello Mill tailrace at Sapello, N. Mex., 1903–4.
      - Manuelitos River near Sapello, N. Mex., 1903–4.
  - Ute Creek near Logan, N. Mex., 1904–1906, 1909.
  - Beaver Creek at Beaver, Okla., 1904–5.
  - Canadian River, North Fork, near Woodward, Okla., 1903–1906.
  - Canadian River, North Fork, near El Reno, Okla., 1902–1908.
  - Canadian River, North Fork, near Oklahoma, Okla., 1899.
  - Canadian River, North Fork, near Eufaula, Okla., 1899.
- Arkansas River canals:
  - Oxford Farmers Canal near Nepesta, Colo., 1903.
  - Colorado-Kansas Canal near Prowers, Colo., 1903.
  - Keese ditch near Prowers, Colo., 1903.

YAZOO RIVER BASIN.

- Tallahatchie River at Batesville, Miss., 1906–1909.
- Tallahatchie River at Philipp, Miss., 1908–9.
- Yazoo River at Greenwood, Miss., 1908–9.
- Yazoo River at Yazoo City, Miss., 1900–1905.
  - Coldwater River at Savage, Miss., 1908–9.
  - Yalobusha River at Grenada, Miss., 1906, 1908–9.
  - Sunflower River at Ruleville, Miss., 1908–9.
  - Sunflower River at Baird, Miss., 1908–9.

HOMOCHITTO RIVER BASIN.

- Homochitto River at Rosetta, Miss., 1906.

RED RIVER BASIN.

- Red River at Arthur City, Tex., 1905–6.
  - Red River, Salt Fork, at Mangum, Okla., 1905–6.
    - Turkey Creek at Olustee, Okla., 1905–1908.
  - Red River, North Fork, near Granite, Okla., 1903–1908.

- Red River, North Fork, near Snyder, Okla., 1905.
- Red River, North Fork, near Headrick, Okla., 1905–1908.
  - Red River, Elm Fork, near Mangum, Okla., 1905–1908.
  - Elk Creek near Hobart, Okla., 1904–1908.
    - Otter Creek near Mountain Park, Okla., 1903–1908.
    - Horse Creek near Mountain Park, Okla., 1905–6.
    - Otter Creek, Dry Fork, near Mountain Park, Okla., 1905–6.
- Washita River near Anadarko, Okla., 1902–1908.
- Ouachita River near Malvern, Ark., 1903–1905.
- Ouachita River near Arkadelphia, Ark., 1905–6.

WHITE RIVER DRAINAGE BASIN.

DESCRIPTION.

White River rises in the Boston Mountains near the western border of Arkansas, nearly 50 miles south of the Arkansas-Missouri line, flows northward into Missouri, then bends southeastward and reenters Arkansas, continuing its general southeasterly course to the southeast corner of Arkansas County, where its channel divides, one part entering Arkansas River and the other Mississippi River. The natural discharge of White River is into the Mississippi. The length of the river from its source to its mouth is about 300 miles by general course, but the stream is very crooked and, including the bends, it is probably not less than 400 miles long.

The important tributaries from the north are North Fork of White River, Black River, and Cache River; those from the south are Kings River, Buffalo Fork of White River, and Red River.

The basin comprises 27,700 square miles, of which 10,000 square miles lie in Missouri and the remainder in northern and eastern Arkansas. Topographically, it consists of two parts—a highland area, 22,200 square miles in extent, lying west of the St. Louis, Iron Mountain & Southern Railway, and an area of lowlands, including 5,500 square miles, lying east of this railroad.

The topography of the highland portion of the basin is rough. The rocks are sandstone, limestone, and shale, lying horizontal. Through these the main stream and all its tributaries have cut ravines that range in depth from a few score feet to more than 1,200 feet. Elevations in the Boston Mountains exceed 2,000 feet above sea level. The elevation of the bed of White River ranges from 1,250 feet at the north base of the mountains to less than 250 feet at Batesville. Throughout the distance between these two points there are no falls and but a few rapids.

The lowland area of the basin is level, and stands only a few feet above the water of the river at average stage. It is cut by numerous sloughs which have been formed by the clogging of the streams and the partial filling of horseshoe lakes. Probably all of it is susceptible to drainage.

The entire area was originally forest covered, but a large proportion of the river bottoms and the level parts of the uplands is now under cultivation. The steep rock-covered slopes, which constitute a considerable part of the area, are still forest covered.

The records kept at the agricultural experiment station at Fayetteville from 1871 to 1907, inclusive, show that the annual rainfall at that place ranges from a minimum of 34.58 inches in 1871 to a maximum of 67.48 inches in 1905. The average for the 37 years was 45.609 inches. The rainfall at Fayetteville is probably fairly representative for that part of the basin that lies within the highland division.

The average snowfall is about 9 inches. Snow lies on the ground but a few days at most, and there is seldom ice enough on the ground to interfere with travel.

Irrigation has not been attempted in this basin, but it is practicable in a small way along the stream bottoms, where the water may be taken from the streams, and on a still smaller scale on the benches of the hill slopes, where water from springs may be stored.

As the valleys are narrow and the banks in most places high, there are many points along the streams where water could be stored without flooding much land. Such storage sites may be found along White River and all its highland tributaries. Numerous large springs of fine water occur throughout the highland area.

Buffalo Fork of White River and that portion of White River above the mouth of Buffalo Fork can be utilized for logging or boating only during the rainy season. A series of Government dams above Batesville will, when completed, render White River navigable the year round as far up as the mouth of Buffalo Fork. In the lowland part of its course White River is navigable for small boats at all seasons.

A survey to determine the available water power along White River and its tributaries is now being conducted. The smaller of the numerous power sites can probably be made to furnish a few hundred horsepower and the larger ones several thousand horsepower.

WHITE RIVER AT BEAVER, ARK.

This station, which is located at the Missouri and North Arkansas Railroad bridge at Beaver, Ark., was established July 17, 1909, to obtain data for use in studying water power, water supply, flood control, storage, and navigation problems.

No important tributaries enter near the station.

The datum of the chain gage, which is fastened to the upstream handrail of the bridge, has not been changed. Measurements at high water are made from this bridge, at low water by wading.

The station is maintained under the direction of the state geologist of Arkansas.

Discharge measurements of White River at Beaver, Ark., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
August 3	W. N. Gladson	75	148	3.5	91
November 20	do	110	497	4.55	399
December 17	do	105	469	4.5	431

NOTE.—Measurements made by wading 1,000 feet above the bridge.

Daily gage height, in feet, of White River at Beaver, Ark., for 1909.

[Reno N. Lowe, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.58	3.2	3.05	3.25	3.7	16		3.3	3.15	3.15	3.85	4.6
2		3.5	3.2	3.05	3.25	3.7	17	4.4	3.3	3.1	3.15	4.1	4.52
3		3.5	3.2	3.05	3.25	3.7	18	4.2	3.3	3.1	3.15	4.25	4.45
4		3.5	3.2	3.05	3.25	3.7	19	4.05	3.3	3.1	3.2	4.7	4.35
5		3.5	3.2	3.05	3.55	6.38	20	4.0	3.3	3.1	3.25	4.5	4.3
6		3.48	3.25	3.05	4.4	8.85	21	3.9	3.25	3.12	3.3	4.35	4.3
7		3.42	3.25	3.05	3.85	7.35	22	3.9	3.22	3.15	3.45	4.15	4.22
8		3.4	3.25	3.05	4.25	6.12	23	3.8	3.2	3.12	3.45	4.12	4.22
9		3.4	3.2	3.25	4.2	5.5	24	3.8	3.2	3.12	3.4	4.0	4.1
10		3.4	3.18	3.25	4.0	5.2	25	3.7	3.2	3.1	3.35	3.9	4.0
11		3.4	3.18	3.2	3.8	4.98	26	3.7	3.2	3.1	3.3	3.85	4.05
12		3.4	3.18	3.15	3.7	4.82	27	3.7	3.2	3.1	3.25	3.8	4.05
13		3.35	3.18	3.15	3.65	4.7	28	3.7	3.2	3.1	3.25	3.72	4.0
14		3.35	3.2	3.25	3.65	4.7	29	3.6	3.25	3.1	3.25	3.7	4.0
15		3.3	3.18	3.15	3.6	4.65	30	3.6	3.25	3.1	3.25	3.7	4.25
							31	3.6	3.22		3.3		3.9

WHITE RIVER NEAR BRANSON, MO.

This station, which is located at the St. Louis, Iron Mountain & Southern Railway bridge near Branson, Mo., was established July 19, 1909, to obtain data for use in studying water power, water supply, flood control, storage, and navigation problems.

Turkey Creek enters the river on the right bank about 600 feet below the section.

The datum of the gage, which is fastened to the downstream guard rail of the bridge, has remained unchanged. At high water measurements are made from this bridge; at low water they are made by wading.

This station is maintained under the direction of the state geologist of Arkansas.

Discharge measurements of White River near Branson, Mo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage. height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
November 22	W. N. Gladson	270	946	3.3	1,280
December 18	do	268	972	3.4	1,110

Daily gage height, in feet, of White River near Branson, Mo., for 1909.

[William Kruger, observer.]

Day.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	3.10	2.55	2.30	2.50	2.85	16	......	2.70	2.45	2.50	3.65	3.55
2	......	3.00	2.50	2.30	2.50	2.85	17	......	2.65	2.45	2.50	3.72	3.50
3	......	3.00	2.50	2.30	2.50	2.80	18	......	2.60	2.45	2.50	3.80	3.40
4	......	3.00	2.48	2.30	2.50	2.92	19	4.00	2.60	2.40	2.45	3.70	3.32
5	......	2.95	2.40	2.30	2.45	3.95	20	3.88	2.55	2.40	2.50	3.65	3.22
6	......	2.95	2.40	2.30	3.05	6.62	21	3.75	2.60	2.40	2.50	3.60	3.15
7	......	2.95	2.40	2.30	3.75	7.05	22	3.65	2.60	2.35	2.50	3.40	3.18
8	......	2.98	2.60	2.30	3.60	6.48	23	3.60	2.60	2.35	2.50	3.30	3.30
9	......	3.15	2.55	2.40	3.30	4.95	24	3.48	2.55	2.38	2.50	3.25	3.20
10	......	3.02	2.55	2.42	3.50	4.45	25	3.40	2.60	2.40	2.50	3.10	3.18
11	......	2.95	2.55	2.50	3.40	4.20	26	3.35	2.50	2.40	2.50	3.00	3.05
12	......	2.90	2.52	2.50	3.28	4.00	27	3.30	2.50	2.40	2.50	3.00	3.00
13	......	2.82	2.45	2.50	3.10	3.82	28	3.25	2.50	2.30	2.50	3.00	3.00
14	......	2.75	2.50	2.50	3.10	3.70	29	3.25	2.50	2.30	2.50	2.92	3.00
15	......	2.75	2.45	2.50	3.10	3.60	30	3.20	2.48	2.30	2.50	2.80	2.90
							31	3.20	2.45	......	2.50	......	3.00

WHITE RIVER NEAR LEAD HILL, ARK.

This station, which is located at Bradley's ferry, 5 miles northeast of Lead Hill, Ark., was established October 1, 1909, to obtain data for use in studying water power, navigation, flood control, and storage problems.

Fishtrap Shoals are about 400 feet below the station.

The gage consists of two vertical sections on the right bank of the river about 100 feet below the ferry. Its datum has not been changed. Measurements are made from the ferryboat.

The station is maintained under the direction of the state geologist of Arkansas.

Discharge measurements of White River near Lead Hill, Ark., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
August 19	W. N. Gladson	300	794	1.1	468
November 22	....do	300	936	2.4	1,400
December 20	....do	292	905	2.4	1,350

Daily gage height, in feet, of White River near Lead Hill, Ark., for 1909.

[Jerry Upshaw, observer.]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	1.1	1.3	1.8	11	1.2	2.4	3.55	21	1.3	2.6	2.3
2	1.1	1.3	1.7	12	1.25	2.3	3.45	22	1.3	2.5	2.0
3	1.1	1.3	1.8	13	1.25	2.1	3.2	23	1.3	2.4	2.0
4	1.1	1.3	1.8	14	1.3	2.0	3.1	24	1.3	2.2	2.1
5	1.1	1.3	4.15	15	1.3	2.0	3.0	25	1.3	2.1	2.0
6	1.1	3.0	5.8	16	1.2	2.0	2.8	26	1.3	2.0	1.8
7	1.1	1.85	5.6	17	1.21	2.5	2.7	27	1.3	1.9	1.7
8	1.1	2.6	6.0	18	1.21	2.7	2.6	28	1.3	1.8	1.7
9	1.48	2.3	4.9	19	1.2	2.8	2.5	29	1.3	1.8	1.6
10	1.2	2.2	4.1	20	1.2	2.55	2.4	30	1.2	1.7	1.6
								31	1.3	......	2.0

WHITE RIVER NEAR COTTER, ARK.

This station, which is located at the St. Louis, Iron Mountain & Southern Railway bridge near Cotter, Ark., was established July 21, 1909, to obtain data for use in studying water power, water supply, flood control, storage, and navigation problems.

The station is about three-fourths of a mile below the mouth of Falling Ash Creek.

The datum of the gage, which is fastened to the upstream guardrail of the bridge, has remained unchanged. Measurements are made from the bridge, from a ferry about 500 feet above, or by wading.

This station is maintained under the direction of the State geologist of Arkansas.

Discharge measurements of White River near Cotter, Ark., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
August 31 [a]	W. N. Gladson	160	308	1.3	455
November 24 [b]	do	420	1,090	2.9	1,740
December 22 [b]	do	400	1,030	2.85	1,660

[a] Measurement by wading. [b] Measurement from the ferry.

Daily gage height, in feet, of White River near Cotter, Ark., for 1909.

[S. Butterfield, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.65	1.4	1.0	1.5	2.2	16		2.0	1.3	1.25	2.4	3.75
2		2.6	1.4	1.0	1.45	2.2	17		1.9	1.2	1.3	2.55	3.5
3		2.45	1.4	1.0	1.4	2.15	18		1.8	1.2	1.3	3.0	3.35
4		2.4	1.3	1.0	1.3	2.1	19		1.8	1.2	1.2	3.25	3.3
5		2.3	1.4	1.0	1.3	3.35	20		1.75	1.2	1.2	3.35	3.15
6		2.3	1.4	1.0	1.95	6.1	21	3.9	1.65	1.3	1.3	3.2	3.0
7		3.15	1.4	1.0	3.35	6.9	22	3.7	1.6	1.3	1.3	3.1	3.0
8		2.45	1.4	1.0	2.45	6.8	23	3.5	1.5	1.25	1.3	3.05	2.9
9		2.35	1.3	1.35	3.05	6.6	24	3.4	1.5	1.2	1.3	2.9	2.8
10		2.2	1.3	1.65	2.95	5.55	25	3.2	1.4	1.2	1.2	2.75	2.65
11		2.1	1.3	1.45	2.7	5.0	26	3.1	1.4	1.2	1.2	2.55	2.5
12		2.3	1.3	1.2	2.9	4.7	27	3.1	1.4	1.2	1.25	2.45	2.5
13		2.25	1.3	1.2	2.65	4.35	28	3.0	1.3	1.1	1.3	2.3	2.5
14		2.1	2.45	1.2	2.55	4.2	29	2.85	1.3	1.1	1.3	2.3	2.35
15		2.0	1.4	1.2	2.45	3.95	30	2.75	1.3	1.0	1.3	2.2	2.3
							31	2.7	1.3		1.4		2.2

WHITE RIVER AT WALLS FERRY, ARK.

This station, which is located at the Government dam at Walls Ferry, Ark., will furnish data necessary in studying water power, navigation, and flood control problems. The discharge of the stream will be computed from the records of the gage heights above the lock, considering the dam as a weir. Discharge measurements will be made in order to determine the proper coefficients to be used. The first measurement was made in November, 1909.

This station is maintained under the direction of the State geologist of Arkansas.

The following discharge measurement was made by W. N. Gladson:

November 28, 1909: Width, 310 feet; area, 1,830 square feet; gage height, 6.8 feet; discharge, 2,790 second-feet.

BUFFALO RIVER NEAR GILBERT, ARK.

This station, which is located at the Missouri & North Arkansas Railroad bridge near Gilbert, Ark., was established July 16, 1909, to obtain data for use in studying water power and storage problems.

Bear Creek is tributary to Buffalo River from the right bank about one-fourth mile above the station.

The datum of the chain gage, which is fastened to the upstream guardrail of the bridge, from which high-water measurements are also made, has not been changed. Low-water measurements are made by wading. Measurements of high water may be complicated by the flow from Bear Creek.

This station is maintained under the direction of the State geologist of Arkansas.

Discharge measurements of Buffalo River near Gilbert, Ark., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
November 29...	W. N. Gladson..	65	98	3.0	131
December 23...	.....do..	68	128	3.2	155

NOTE.—Measurements made by wading.

Daily gage height, in feet, of Buffalo River near Gilbert, Ark., for 1909.

[Mrs. R. J. Williams, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	2.6	2.2	2.2	2.5	3.0	16	3.0	2.5	2.3	2.3	2.9	4.2
2	......	2.6	2.2	2.2	2.4	3.0	17	3.0	2.5	2.2	2.3	3.9	4.0
3	......	2.5	2.2	2.2	2.4	3.8	18	2.9	2.4	2.2	2.3	4.1	3.6
4	......	2.5	2.2	2.2	2.4	3.6	19	2.8	2.4	2.2	2.3	3.9	3.6
5	......	2.5	2.3	2.2	2.4	3.6	20	2.8	2.4	2.2	2.3	3.6	3.4
6	......	2.5	2.3	2.2	2.5	4.3	21	2.7	2.4	2.3	2.3	3.4	3.4
7	......	2.6	2.3	2.2	2.5	4.8	22	2.7	2.3	2.3	2.3	3.3	3.3
8	......	2.7	2.3	2.2	2.5	4.3	23	2.7	2.3	2.3	2.3	3.2	3.2
9	......	2.7	2.3	2.6	2.6	4.0	24	2.7	2.3	2.3	2.3	3.1	3.2
10	......	2.6	2.3	2.4	2.5	3.7	25	2.7	2.3	2.3	2.3	3.1	3.2
11	......	2.6	2.3	2.3	2.5	3.6	26	2.7	2.3	2.3	2.3	3.0	3.1
12	......	2.6	2.3	2.3	2.6	4.6	27	2.6	2.2	2.3	2.3	3.0	3.1
13	......	2.5	2.3	2.3	2.6	5.1	28	2.6	2.2	2.3	2.3	2.9	3.0
14	......	2.5	2.2	2.3	2.7	4.8	29	2.6	2.2	2.3	2.3	2.9	3.0
15	......	2.5	2.3	2.3	2.7	4.5	30	2.6	2.2	2.3	2.3	2.9	2.9
							31	2.6	2.2	......	2.3	......	2.9

NORTH FORK RIVER NEAR HENDERSON, ARK.

This station, which is located at Smith's ferry, near Henderson, Ark., was established July 23, 1909, to obtain data for use in studying water power, storage, and navigation problems.

Bayou Creek enters on the left bank about 1¼ miles above the station.

The gage consists of three vertical sections on the left bank near the ferry. Its datum has not been changed. Measurements are made from the ferryboat or by wading at low water.

This station is maintained under the direction of the State geologist of Arkansas.

Discharge measurements of North Fork River near Henderson, Ark., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
September 4[a]	W. N. Gladson	210	709	1.4	851
November 26	do	230	718	1.6	719
December 21	do	240	777	1.75	911

[a] Measurement by wading one-half mile below the ferry.

Daily gage height, in feet, of North Fork River near Henderson, Ark., for 1909.

[F. S. Field, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.1	1.7	1.5	1.6	1.8	16		1.7	1.75	1.4	1.7	1.9
2		2.0	1.6	1.5	1.65	1.85	17		1.6	1.65	1.5	1.75	1.8
3		2.9	1.55	1.5	1.8	1.9	18		1.6	1.5	1.5	1.7	1.7
4		2.9	1.5	1.4	1.75	1.8	19		1.6	1.5	1.45	1.65	1.7
5		2.8	1.65	1.45	1.65	1.8	20		1.5	1.5	1.4	1.7	1.7
6		2.8	1.6	1.5	1.6	1.85	21		1.4	1.65	1.5	1.6	1.75
7		2.7	1.5	1.6	1.7	1.9	22		1.4	1.75	1.5	1.65	1.8
8		2.65	1.6	1.6	1.8	2.0	23	2.2	1.4	1.6	1.5	1.7	1.8
9		2.55	1.6	1.6	1.9	2.5	24	2.15	1.35	1.5	1.5	1.65	1.7
10		2.5	1.55	1.6	1.85	2.65	25	2.1	1.3	1.5	1.5	1.6	1.6
11		2.4	1.5	1.5	1.75	1.9	26	2.1	1.3	1.5	1.5	1.6	1.6
12		2.35	1.5	1.5	1.65	1.9	27	2.05	1.3	1.5	1.45	1.6	1.55
13		1.95	1.5	1.5	1.6	1.8	28	2.0	1.3	1.5	1.4	1.7	1.5
14		1.7	1.7	1.45	1.5	1.85	29	2.0	2.0	1.6	1.4	1.7	1.6
15		1.7	1.85	1.4	1.55	1.85	30	2.55	2.0	1.55	1.4	1.8	1.6
							31	2.1	1.9		1.5		1.6

LITTLE RED RIVER AT PANGBURN, ARK.

This station, which is located at Skillern's ferry, near Pangburn, Ark., was established July 15, 1909, to obtain data for use in studying water power, water supply, storage, and navigation problems.

Big Red Creek joins Little Red River about one-half mile below the station.

This stream is used to considerable extent for running logs. Log jams above and below the station affect the gage for short periods. Ice rarely, if ever, forms on this stream.

The gage consists of three vertical sections on the right bank near the ferry. Its datum has not been changed. Measurements are made from a ferryboat or by wading at low water.

This station is maintained under the direction of the State geologist of Arkansas.

Discharge measurements of Little Red River near Pangburn, Ark., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
November 28...	W. N. Gladson..	170	552	3.1	329
December 25...	.....do..	200	674	3.7	637

Daily gage height, in feet, of Little Red River near Pangburn, Ark., for 1909.

[A. J. Stolz, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	2.0	1.5	1.4	1.6	3.0	16	3.2	1.6	1.4	1.5	2.9	7.0
2	......	1.9	1.4	1.5	1.6	2.9	17	3.0	1.7	1.4	1.5	2.9	6.4
3	......	1.9	1.4	1.5	1.6	2.9	18	3.2	1.8	1.3	1.5	8.4	5.8
4	......	1.8	1.5	1.5	1.6	5.4	19	3.1	1.7	1.3	1.5	6.4	5.2
5	......	1.8	1.5	1.5	1.5	4.8	20	3.1	1.7	1.3	1.5	5.0	4.9
6	......	1.8	1.5	1.6	1.5	4.5	21	3.1	1.7	1.6	1.6	4.3	4.7
7	......	1.8	1.8	1.6	2.2	5.1	22	2.1	1.7	1.8	1.5	3.9	4.3
8	......	1.7	1.6	1.5	2.5	5.0	23	2.3	1.6	2.2	1.6	3.7	3.9
9	......	1.7	1.5	1.5	2.4	4.8	24	2.2	1.6	1.8	1.6	3.5	3.8
10	......	1.7	1.5	1.5	2.3	4.4	25	2.2	1.6	1.6	1.6	3.6	3.7
11	......	1.7	1.5	1.4	2.4	4.5	26	2.1	1.6	1.6	1.6	3.6	3.7
12	......	1.7	1.4	1.4	3.0	7.5	27	2.1	1.6	1.5	1.6	3.5	3.6
13	......	1.7	1.4	1.4	2.9	13.4	28	2.7	1.6	1.5	1.6	3.4	3.5
14	2.65	1.6	1.4	1.5	2.9	10.6	29	2.2	1.6	1.4	1.5	3.2	3.4
15	2.9	1.6	1.4	1.5	3.0	8.2	30	2.0	1.5	1.4	1.5	3.0	3.3
							31	2.0	1.5	......	1.5	......	3.2

ARKANSAS RIVER DRAINAGE BASIN.

DESCRIPTION.

The western rim of the Arkansas basin is formed by three of the highest mountain ranges of Colorado—the Saguache, Sangre de Cristo, and Culebra, each having summits more than 14,000 feet in altitude. The melting of the almost perpetual snow that mantles the high peaks near the north end of this rim furnishes water for three small creeks, the East, Lake, and Tennessee forks, which unite near Leadville to form the Arkansas.

From the junction of the forks the river flows a little east of south for about 75 miles, then turns to the east and cuts through a canyon whose perpendicular walls attain elevations of more than 2,000 feet above the water's edge, emerging finally into the plains region near Canon City. From Canon City to the Colorado-Kansas State line its general course is eastward for about 200 miles. Entering Kansas the river runs for 140 miles by general course a little south of east; it then makes a bold curve to the north, forming what is known as the Great Bend, below which it flows southeastward across Oklahoma to its junction with the Mississippi in northeastern Arkansas. The entire length of the stream from source to mouth is about 1,500 miles and its drainage basin includes 177,500 square miles.

In its upper course the Arkansas is fed by numerous small streams, generally short, which lie wholly in or have their sources in the mountains. Those that head in the mountains and flow out onto the prairies are used more or less for irrigation. The most important of these tributaries are Greenhorn, Huerfano, Apishapa, and Purgatory rivers. The plains tributaries include Black Squirrel, Horse, Two Butte and Big Sandy Creeks, Salt Fork, Cimarron, Verdigris, Grand, and Canadian rivers, and scores of smaller streams. The largest of these tributaries is Canadian River.

Above Pueblo, Colo., the drainage basin is generally mountainous, but toward the south the elevation decreases and the country is well marked by stream channels that trend in a general northeasterly direction. The streams on the north flow generally southward when they emerge from the mountains.

At the base of the mountains are the foothills, irregular and seared by canyons, and marked by disconnected mesas and buttes of different but moderate altitudes; beyond are great level plains, extending far to the east and constituting a portion of what was formerly known as the Great American Desert. East of the foothills and north of the river the topography is that typical of the Great Plains region, but to the south the surface of the plains is generally more accented. That part of the drainage basin that extends from the mountains to the Colorado-Kansas line embraces an area of about 25,000 square miles. Beyond this is the flat semiarid section of western Kansas, and then the more humid country in eastern Kansas, Oklahoma, and Arkansas.

The rocks exposed in the mountainous area present great variety, ranging from the metamorphic granites of Pikes Peak and the Royal Gorge of the Arkansas to the glacial drift in the upper valley of the Arkansas from Salida to Leadville and in the upper Grape Creek Range. Next to the granites the eruptive rocks are most common, and sedimentary rocks are found over wide areas.

In the plains region the principal rock exposures seen along the heavily eroded stream channels are shales, sandstone, and limestone in alternating layers. The soil cover, which is necessarily rather meager in the mountainous section, varies in the plains region from the upland sands and gravels of the mesas to the sandy loams and adobe clays of the river valleys. The adobe soils are very friable and dry and melt away rapidly under the action of water. Many of the dry intermittent channels, usually termed arroyos, are narrow and have high vertical walls, and are cut deeper by each succeeding flood. The vegetation is scanty, consisting of native grasses, sagebrush, chico, and cactus pads. The ranges have been very closely pastured, making conditions conducive to an excessive flood run-off.

Above Canon City the fall of the river is about 40 feet to the mile. The elevation at Canon City is 5,300 feet; at the Colorado-Kansas state line, 220 miles below, the elevation is 3,350 feet, making the average fall about 9 feet per mile. At the mouth the river has an elevation slightly exceeding 100 feet above sea level.

The drainage basin of Arkansas River contains about 1,000 square miles of merchantable timber land and considerably more than that amount of woodland; the rest, except for the considerable area under cultivation, may be classed as barren and sagebrush land.

The principal source of the water which the river bears to the plains is the precipitation along the crest of the high ranges. This is mainly in the form of snow, and amounts to 20 or 30 inches each year. From the foothills to Arkansas City the precipitation ranges from 12 to 35 inches, being 25 to 35 inches in the last 100 miles below Hutchinson. The natural storage in the basin is limited to a few mountain lakes of glacial origin.

The streams of this drainage area are subject to floods of two kinds—the annual spring floods caused by the melting of the snows in the headwater regions and floods caused by the violent storms, locally known as cloudbursts, in the foothills and plains regions. Occasionally, too, the river runs dry, and many of the tributaries are intermittent in character.

As altitudes within this basin range from 14,000 feet almost down to sea level, the climatic conditions vary greatly. In the mountainous sections the winters are severe, the snowfall is heavy, and the rivers have a thick ice cover for several months. As the altitude decreases the winters become milder.

At the present time about half a million acres of land are under irrigation on Arkansas River and its tributaries in Colorado, but beyond the Colorado line only a very few thousand acres are irrigated. The Garden City project of the United States Reclamation Service will eventually provide for the irrigation of probably 15,000 acres in the Arkansas Valley in western Kansas, principally by pumping the underflow.

Numerous reservoirs now in operation along the Arkansas, together with direct diversions for irrigation, provide for the use of the greater part of the flow of Arkansas River in Colorado. The largest reservoirs are in the system of the Great Plains Reservoir Company, on the north side of the river in the eastern part of the State. The reservoirs of this system are supplied by feeder canals, and have a combined capacity of almost 200,000 acre-feet. Other reservoirs now contemplated or under construction, on the tributaries of the Arkansas, will provide for the irrigation of a large additional area. These reservoirs are necessitated by the intermittent character of the streams upon which they are situated. The basin contains many excellent reservoir sites. The flood on the Arkansas in October, 1908, illustrates the possibility for additional storage in some of them. (For report on this flood, see Water-Supply Paper 247, p. 35.)

On account of the use of water for irrigation in the open country, power development is necessarily confined to the upper reaches of the Arkansas and its tributaries. It seems probable that, with proper storage, about 100,000 horsepower can be developed. Somewhat over 5,000 horsepower is now being used.

The years of greatest average flow on the upper Arkansas since the beginning of measurements seem to have been 1891 and 1899. The flow in 1905 was also very high and that in 1906 and 1907 was nearly as great. The year of lowest flow is 1902, while 1908 is second.

ARKANSAS RIVER AT SALIDA, COLO.

A station was maintained on Arkansas River at Salida under the direction of the United States Geological Survey from 1895 to 1903.[1] The station was reestablished November 3, 1909, by the state engineer of Colorado, who placed a Bristol automatic gage with an auxiliary slope gage about a block below the concrete bridge on the road from town to the Denver & Rio Grande Railroad depot. The records furnish data concerning the amount of water available for irrigation.

The new and old stations bear the same relation to tributaries and diversions, but are at different sections.

The gage has no determined relation to the gage used in 1903. Discharge measurements are made from the concrete bridge.

On account of springs in the vicinity of the station, the channel is open throughout the winter months, making a very favorable location for the gage.

Discharge measurements of Arkansas River at Salida, Colo., in 1909.

Date.	Hydrographer.	Area of section.	Gage height.	Discharge.
		Sq. ft.	*Feet.*	*Sec.-ft.*
November 3	Grieve and Chatfield	174	1.60	547
December 15	C. L. Chatfield	102	.70	243

---

[1] For description, see Water-Supply Paper U. S. Geol. Survey No. 99, p. 301.

Daily gage height, in feet, of Arkansas River at Salida, Colo., for 1909.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1	....	1.05	11	1.15	0.85	21	1.15	0.7
2	....	1.1	12	1.15	.85	22	1.1	.8
3	....	1.1	13	1.1	.9	23	1.1	.85
4	....	.95	14	1.0	.85	24	1.1	.85
5	....	.8	15	1.05	.8	25	1.05	.8
6	....	.9	16	1.1	.75	26	1.1	.8
7	....	.9	17	1.1	.8	27	1.1	.85
8	....	.9	18	1.1	.7	28	1.05	.8
9	....	.9	19	1.1	.65	29	1.1	.8
10	....	.95	20	1.15	.65	30	1.1	.8
						31	....	.8

Daily discharge, in second-feet, of Arkansas River at Salida, Colo., for 1909.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1	....	325	11	358	262	21	358	225
2	....	340	12	358	262	22	340	250
3	....	340	13	340	275	23	340	262
4	....	292	14	310	262	24	340	262
5	....	250	15	325	250	25	325	250
6	....	275	16	340	238	26	340	250
7	....	275	17	340	250	27	340	262
8	....	275	18	340	225	28	325	250
9	....	275	19	340	212	29	340	250
10	....	292	20	358	212	30	340	250
						31	....	250

NOTE.—These discharges are based on the rating curve used by the State engineer of Colorado. It is fairly well defined.

Monthly discharge of Arkansas River at Salida, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
November 11-30	358	310	337	13,400
December	340	212	263	16,200

ARKANSAS RIVER AT CANON CITY, COLO.

This station, which was established April 17, 1889, is located at the mouth of the canyon, just below the suspension footbridge at Hot Springs Hotel, about 1½ miles above the Denver & Rio Grande Railroad depot at Canon City, Colo.

The records at this point show the greater part of the run-off of the river and are valuable both for power and irrigation projects.

Grape Creek enters about one-eighth of a mile above the station and Oil Creek comes in about 5 miles below. The drainage area comprises about 3,000 square miles. North and South Canyon ditches divert water above the station, and their flow is not included in the run-off. No accurate records have been kept of the discharge in these canals but the combined flow is from 50 to 100 second-feet during the irrigation season. Some water is also diverted for the irrigation of a few thousand acres on the upper Arkansas and its tributaries.

The flow of the river is affected by ice for three or four months during the winter season.

On October 4, 1895, a new rod gage was established on the left bank, opposite the original gage and at the same datum. This gage read 0.4 foot lower than the old gage at low stages, but at high water both gages read the same. This new gage was used until August 26, 1902, when another gage was established on the right bank at the datum of the original gage, though it is situated a short distance farther downstream. The present chain gage is a few feet upstream from the cable. In September, 1909, the state engineer established a Bristol self-recording gage near the location of the chain gage, but with a datum 2 feet higher. Both gages have been read since that time. Measurements are made from a cable.

As the stream bed is rough it is difficult to obtain very accurate measurements at high stages. Moreover, the channel is subject to considerable shifting, which makes the estimates of daily discharge rather uncertain, especially after violent flood.

Discharge measurements of Arkansas River at Canon City, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 6[a]	W. B. Freeman	88	152	3.40	388
June 10	Freeman, Lyon, and Grieve	106	423	6.15	2,870
June 28	W. B. Freeman	106	443	6.40	3,000
July 21	Lyon and Russell	100	289	5.00	1,530
August 9	Thos. Grieve		232	4.20	882
August 21	G. H. Russell	98	223	4.65	1,080
September 1	C. L. Chatfield	100	212	4.75	1,310
September 16	do		284	5.10	1,310
September 18	G. H. Russell	100	235	4.95	1,220
October 11	Thos. Grieve	96	196	4.30	735
October 14	G. H. Russell	96	192	4.20	680
November 4	Chatfield and Grieve	117	188	4.13	631
November 23	G. H. Russell	97	180	4.10	559
December 15[b]	C. L. Chatfield		143	3.95	427
December 21[b]	G. H. Russell	45	81	3.65	276

[a] Wading measurement.

[b] Ice along edges.

Daily gage height, in feet, of Arkansas River at Canon City, Colo., for 1909.

[S. R. McKissick, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.15	4.65	6.25	4.7	4.8	4.3	4.0	4.1
2		3.0	4.6	6.4	4.7	4.8	4.2	4.1	4.1
3		3.05	4.7	6.4	4.5	4.65	4.2	4.1	4.1
4		3.1	5.2	6.7	4.2	4.7	4.2	4.0	4.0
5		3.2	5.7	7.0	4.25	5.45	4.25	3.9	3.9
6		3.35	5.75	6.5	4.15	6.4	4.3	3.9	3.9
7		3.45	5.95	5.9	4.15	6.0	4.35	3.85	4.0
8		3.55	6.1	5.9	4.4	6.05	4.35	3.8	4.0
9		3.65	5.95	5.75	4.25	6.0	4.35	3.8	4.05
10		3.75	6.05	5.6	4.2	5.8	4.3	3.9	4.1

Daily gage height, in feet, of Arkansas River at Canon City, Colo., for 1909—Continued.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	....	4.05	6.25	5.5	4.25	5.35	4.3	3.9	4.1
12	....	4.05	6.35	5.25	4.1	5.25	4.3	3.9	4.0
13	....	4.0	6.55	5.05	4.4	5.45	4.2	3.9	4.05
14	....	4.0	6.3	4.85	4.2	5.3	4.15	3.9	4.1
15	....	4.0	5.95	4.85	4.5	5.2	4.1	4.0	4.0
16	....	3.9	5.9	4.95	4.25	5.1	4.1	4.0	4.0
17	....	4.0	6.05	4.8	5.35	5.0	4.1	3.95	4.0
18	....	4.0	6.65	4.75	7.95	4.9	4.1	4.0	3.7
19	....	4.1	7.05	4.7	6.2	4.8	4.1	4.05	3.6
20	3.45	4.25	7.25	4.65	4.55	4.75	4.0	4.0	3.6
21	3.3	4.35	6.65	4.85	4.95	4.5	4.0	4.15	3.6
22	3.2	4.35	6.25	5.3	4.6	4.5	4.1	4.1	3.75
23	3.15	4.5	6.15	5.05	4.3	4.5	4.2	4.1	4.05
24	3.1	4.5	6.85	5.2	4.3	4.5	4.2	4.1	4.1
25	3.1	4.5	6.7	5.4	4.6	4.45	4.2	4.1	4.0
26	3.1	4.4	6.45	5.15	4.4	4.4	4.1	4.05	4.0
27	3.15	4.5	6.45	5.2	4.4	4.4	4.1	4.05	4.1
28	3.2	4.7	6.35	5.1	4.3	4.3	4.1	4.05	4.1
29	3.25	4.85	6.35	5.1	4.45	4.3	4.05	4.05	4.1
30	3.2	4.8	6.4	4.95	4.5	4.3	4.0	4.1	4.05
31	....	4.65	....	4.75	4.75	....	4.0	....	4.15

NOTE.—Probable ice conditions December 4 to 31.

Daily discharge, in second-feet, of Arkansas River at Canon City, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	292	1,180	3,000	1,220	1,360	695	520	583
2	....	236	1,130	3,190	1,220	1,350	620	583	583
3	....	254	1,220	3,190	1,040	1,170	625	583	583
4	....	273	1,740	3,590	811	1,190	630	520	552
5	....	311	2,320	3,990	848	2,040	670	464	400
6	....	370	2,380	3,320	777	3,260	710	464	400
7	....	410	2,620	2,560	777	2,700	755	438	455
8	....	452	2,800	2,560	962	2,740	760	412	455
9	....	497	2,620	2,380	848	2,630	765	412	484
10	....	544	2,740	2,200	811	2,320	725	464	612
11	....	712	3,000	2,080	848	1,730	729	464	612
12	....	712	3,120	1,790	743	1,580	729	464	455
13	....	680	3,390	1,570	962	1,790	652	464	484
14	....	680	3,060	1,370	811	1,580	618	464	612
15	....	680	2,620	1,370	1,040	1,440	583	520	455
16	....	622	2,560	1,470	810	1,310	583	520	455
17	....	680	2,740	1,320	1,960	1,240	553	492	455
18	....	680	3,520	1,270	5,400	1,170	583	520	300
19	....	743	4,060	1,220	3,030	1,070	583	552	255
20	410	848	4,320	1,180	1,000	1,030	520	520	255
21	350	923	3,520	1,370	1,390	810	520	618	255
22	311	923	3,000	1,850	1,040	810	583	583	240
23	292	1,040	2,870	1,570	790	820	652	583	280
24	273	1,040	3,790	1,740	800	820	652	583	280
25	273	1,040	3,590	1,960	1,080	790	652	583	280
26	273	962	3,260	1,680	900	760	583	552	280
27	292	1,040	3,260	1,740	910	760	583	552	280
28	311	1,220	3,120	1,630	840	690	583	552	280
29	330	1,370	3,120	1,630	980	690	552	552	280
30	311	1,320	3,190	1,470	1,040	690	520	583	280
31	....	1,180	....	1,270	1,300	....	520	....	280

NOTE.—These discharges are based on rating curves applicable as follows: April 20 to August 15, well defined below 3,000 second-feet; August 15 to October 10, indirect method for shifting channels; October 11 to December 4, fairly well defined; December 5 to December 21, based on measurements under slight ice conditions; December 22 to 31, estimated on account of ice conditions.

Monthly discharge of Arkansas River at Canon City, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April (20–30)	410	273	311	6,790	B.
May	1,370	236	733	45,100	A.
June	4,320	1,130	2,860	170,000	B.
July	3,990	1,180	2,020	124,000	A.
August	5,400	743	1,190	73,200	B.
September	3,260	690	1,410	83,900	B.
October	765	520	623	38,300	A.
November	618	412	519	30,900	A.
December	612	240	402	24,700	C.
The period				597,000	

ARKANSAS RIVER AT PUEBLO, COLO.

This station was established September 30, 1894, at the Santa Fe Avenue Bridge, Pueblo, Colo. On July 10, 1898, another gage was established on the east side of Main Street Bridge, which was used until March 3, 1900. Then a staff gage fastened to the retaining wall, a short distance below the Union Avenue Bridge, was used to July 14, 1902. From July 14, 1902, until July 7, 1905, readings were taken at a rod gage, having a different datum, located just above this bridge. The present chain gage on the Main Street Bridge has been in use since July 7, 1905. Measurements are made from this bridge.

As this station is near the head of the principal irrigated portion of the Arkansas Valley and above the head gates of the larger canals, the data are especially valuable to water superintendents and the State water commissioners in making distribution of water to the canals below.

No important tributaries enter within several miles above the station. Fountain Creek enters just below, and the Huerfano, the most important tributary in that vicinity, comes in about 20 miles below.

At various points above this station water is diverted for the irrigation of about 70,000 acres of land. The diversion for the Pueblo water supply also takes out above. Additional filings for irrigation above this station on the Arkansas are impossible, except for storage on some of the minor tributaries.

Slush and flowing ice are usually found at this station during the winter months and sometimes the river is frozen over or affected by ice jams below, but the results are rarely influenced by ice conditions for more than two months during the year. As noted above, numerous changes have been made in the datum of the gage.

Very good measurements can be obtained at this point, although the channel sometimes shifts considerably during floods.

Discharge measurements of Arkansas River at Pueblo, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 5	W. B. Freeman	67	66	1.74	106
May 23	G. J. Lyon	150	282	3.20	1,050
June 5	do	150	432	3.95	2,310
June 10	W. B. Freeman	152	439	4.35	2,470
June 24	do	152	477	4.64	2,610
July 16	Thos. Grieve		312	3.38	1,280
July 22	G. H. Russell	150	306	3.56	1,370
July 23	Thos. Grieve		331	3.52	1,370
July 30	do		346	3.65	1,580
August 7	do		196	2.63	548
August 25	G. H. Russell	146	266	3.18	980
September 16	C. L. Chatfield	151	366	3.72	1,710
September 17	do	150	347	3.60	1,590
October 7	Thos. Grieve	151	262	3.00	949
October 15	do	150	221	2.76	696
October 18	G. H. Russell	148	213	2.70	685
November 5	C. L. Chatfield	79	168	2.49	494
November 24	G. H. Russell	145	187	2.65	595
December 16	C. L. Chatfield		181	2.52	567
December 21 [a]	G. H. Russell	111	128	2.55	268

[a] Ice conditions.

Daily gage height, in feet, of Arkansas River at Pueblo, Colo., for 1909.

[D. J. Cox, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.2	3.3	4.65	3.3	3.35	2.95	2.6	2.6
2		2.05	3.25	4.75	3.3	3.4	2.9	2.6	2.6
3		2.0	3.25	4.65	3.3	3.3	2.9	2.6	2.6
4		1.9	3.5	4.7	2.95	4.2	2.9	2.7	2.7
5		1.85	4.1	4.9	2.95	4.3	2.9	2.55	2.5
6		1.9	4.65	5.45	2.8	4.8	2.9	2.5	2.5
7		2.0	4.55	4.4	2.75	4.05	3.0	2.6	2.5
8		2.2	4.65	4.2	2.75	5.1	3.1	2.6	2.55
9		2.3	4.55	4.05	3.1	5.0	3.1	2.5	2.6
10		2.35	4.3	4.0	2.9	4.8	3.0	2.5	2.7
11		2.65	4.6	3.85	2.9	4.1	3.0	2.5	2.7
12		2.75	4.7	3.65	2.9	4.0	3.0	2.55	2.6
13		2.8	4.7	3.5	2.9	4.1	3.0	2.6	2.7
14		2.8	5.05	3.5	3.2	4.05	2.9	2.6	2.6
15		2.8	4.35	3.3	3.4	3.85	2.85	2.6	2.6
16		2.7	4.25	3.4	2.95	3.65	2.8	2.6	2.6
17		2.6	4.25	3.55	3.25	3.65	2.7	2.6	2.6
18		2.6	4.65	3.35	6.05	3.55	2.7	2.6	1.95
19		2.7	5.45	3.25	4.65	3.65	2.7	2.6	2.0
20	2.3	2.85	5.55	3.2	4.05	3.45	2.7	2.6	2.35
21	2.3	3.15	5.45	3.1	3.4	3.35	2.65	2.65	2.6
22	2.3	3.2	4.6	3.7	4.55	3.3	2.6	2.7	2.75
23	2.4	3.2	4.45	3.6	2.9	3.3	2.7	2.65	3.2
24	2.35	3.3	4.8	4.7	2.8	3.3	2.7	2.6	3.4
25	2.3	3.2	5.3	4.0	3.0	3.3	2.7	2.5	3.5
26	2.0	3.1	4.85	3.8	2.95	3.1	2.6	2.5	3.05
27	2.0	3.1	4.65	3.65	3.0	3.1	2.6	2.5	3.15
28	2.05	3.2	4.7	3.7	3.0	3.05	2.6	2.55	3.3
29	2.1	3.4	4.75	3.75	3.0	3.0	2.6	2.6	3.15
30	2.15	3.45	4.7	3.6	3.15	2.95	2.6	2.6	3.2
31		3.35		3.2	3.15		2.6		3.3

NOTE.—Probable ice conditions December 21 to 31.

Daily discharge, in second-feet, of Arkansas River at Pueblo, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	300	1,180	2,850	1,180	1,230	835	550	550
2	....	228	1,120	2,990	1,180	1,280	790	550	550
3	....	205	1,120	2,850	1,180	1,180	790	550	550
4	....	165	1,390	2,920	835	2,240	790	625	625
5	....	145	2,120	3,200	835	2,380	790	515	480
6	....	165	2,850	4,000	705	3,060	790	480	480
7	....	205	2,710	2,500	665	2,850	880	550	480
8	....	300	2,850	2,240	665	3,500	975	550	515
9	....	355	2,710	2,050	975	3,350	975	480	550
10	....	385	2,380	1,990	790	3,060	880	480	625
11	....	588	2,780	1,800	790	2,120	880	480	625
12	....	665	2,920	1,560	790	1,990	880	515	550
13	....	705	2,920	1,390	790	2,120	880	550	625
14	....	705	3,420	1,390	1,080	2,050	790	550	550
15	....	705	2,440	1,180	1,280	1,800	748	550	550
16	....	625	2,310	1,280	835	1,560	705	550	550
17	....	550	2,310	1,450	1,120	1,560	625	550	550
18	....	550	2,850	1,230	4,920	1,450	625	550	185
19	....	625	4,000	1,120	2,850	1,560	625	550	205
20	355	748	4,160	1,080	2,050	1,340	625	550	385
21	355	1,020	4,000	975	1,280	1,230	588	588	268
22	355	1,080	2,780	1,620	2,710	1,180	550	625	320
23	415	1,080	2,570	1,500	790	1,180	625	588	320
24	385	1,180	3,060	2,920	705	1,180	625	550	320
25	355	1,080	3,780	1,990	880	1,180	625	480	320
26	205	975	3,130	1,740	835	975	550	480	320
27	205	975	2,850	1,560	880	975	550	480	320
28	228	1,080	2,920	1,620	880	928	550	515	320
29	250	1,280	2,990	1,680	880	880	550	550	320
30	275	1,340	2,920	1,500	1,020	835	550	550	320
31	....	1,130	....	1,080	1,020	....	550	....	320

NOTE.—The above discharges are based on a rating curve which is fairly well defined between 415 and 1,990 second-feet. Ice conditions December 21 to 31; flow estimated.

Monthly discharge of Arkansas River at Pueblo, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April 20-30	415	205	308	6,720	B.
May	1,340	145	682	41,900	B.
June	4,160	1,120	2,720	162,000	B.
July	4,000	975	1,910	117,000	B.
August	4,920	665	1,210	74,400	B.
September	3,500	835	1,740	104,000	B.
October	975	550	716	44,000	B.
November	625	480	538	32,000	B.
December	625	185	440	27,100	C.
The period	....	....	....	609,000	

ARKANSAS RIVER AT LAS ANIMAS, COLO.

On May 13, 1898, a station was established at a wagon bridge about half a mile north of Las Animas. A rod gage was fastened to one of the bridge piers. No continuous records were obtained, as the gage has only been read occasionally and but few discharge measurements made. On August 1, 1909, the station was reestablished by the State engineer of Colorado. It is believed the same gage was used and that the datum remained unchanged. The bed of the stream is very shifting, and owing to the skew of the bridge measurements must be made by wading at various sections. The station is of no value for high-water measurements.

Available data are insufficient to warrant estimates of daily discharge.

Discharge measurements of Arkansas River at Las Animas, Colo., in 1909.

Date.	Hydrographer.	Area of section.	Gage height.	Discharge.
		Sq. ft.	*Feet.*	*Sec.-ft.*
August 1	Thos. Grieve	67	1.80	117
August 3	do	31	1.50	53
November 10	C. L. Chatfield	69	1.65	119

NOTE.—Measurements made by wading below the bridge.

Daily gage height, in feet, of Arkansas River at Las Animas, Colo., for 1909.

[S. W. Dobbins, observer.]

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1	......	1.8	1.6	11	0.9	4.5	......	21	4.4	2.0	......
2	......	1.9	1.6	12	.7	4.2	......	22	3.6	2.0	......
3	......	2.0	1.7	13	.8	3.2	......	23	2.5	1.9	......
4	0.5	2.8	1.6	14	1.0	4.0	......	24	1.5	1.9	......
5	.5	2.5	1.4	15	1.5	4.2	......	25	1.5	1.7	......
6	.6	6.0	1.4	16	1.4	3.1	......	26	1.5	1.7	......
7	.6	4.5	1.8	17	1.5	2.2	......	27	1.6	1.8	......
8	.7	4.6	1.7	18	3.3	2.0	......	28	1.9	1.8	......
9	.8	6.3	1.9	19	3.0	2.0	......	29	1.7	1.7	......
10	.8	5.8	......	20	6.0	2.1	......	30	1.5	1.7	......
								31	1.5	......	......

ARKANSAS RIVER AT HOLLY, COLO.

This station, which was established October 15, 1907, is located at the pile highway bridge one-half mile southeast of Holly, Colo., about 4 miles above the Colorado-Kansas line.

As no important diversions are made between the two points the data obtained at this station have special value as showing the amount of surface water passing from Colorado to Kansas.

The station is just above the mouth of Wild Horse Creek and about 1 mile below the mouth of Two Butte Creek. The drainage area is about 25,000 square miles.

As nearly half a million acres of land are under irrigation above this point most of the ordinary flow of the stream is diverted during the irrigation season, while during the winter months it is used to fill up the numerous storage reservoirs in the basin. Except during periods of heavy flood, the flow at Holly consists chiefly of return waters. The stream flow is little affected by ice.

The gage heights here published have all been referred to the same datum, though a rod gage at a different datum was used during part of 1908. During high stages measurements are made from highway bridge and during low stages by wading at miscellaneous sections.

Fairly good measurements can be taken at this point, but in order to obtain accurate records of daily discharge it is necessary to take them frequently on account of the extremely shifting character of the channel.

Discharge measurements of Arkansas River at Holly, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet.*	*Sec.-ft.*
April 17 [a]	G. J. Lyon	37	9.7	0.13	5.4
May 8 [a]	do	23	8.6	.20	12.5
May 30 [a]	do	22	6.4	.15	5.4
July 10	do	284	243	1.47	409
August 13 [a]	do	7.5	8.6	.30	7.1
August 26	G. H. Russell	211	225	1.90	500
September 6	C. L. Chatfield	251	266	1.90	706
November 10 [a]	do	106	54	1.25	90
December 31 [b]	G. H. Russell	206	207	2.20	431

[a] Made by wading.

[b] Ice conditions. Made by wading.

Daily gage height, in feet, of Arkansas River at Holly, Colo., for 1909.

[S. W. Jones, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.45	0.5	0.3	0.5	0.25	0.2	0.9	1.1	0.9	1.5	1.2	1.6
2	.45	.5	.3	.4	.2	.1	.9	1.1	.8	1.45	1.25	1.55
3	.45	.45	.4	.4	.2	.1	.8	1.05	.8	1.5	1.3	1.65
4	.45	.4	.4	.4	.2	.1	.8	.9	.8	1.4	1.25	1.6
5	.4	.3	.4	.4	.2	.1	.7	.8	.7	1.45	1.25	1.6
6	.4	.3	.4	.4	.2	.15	.6	.8	1.0	1.35	1.15	1.55
7	.4	.3	.4	.4	.2	.15	1.9	.7	3.45	1.55	1.1	1.5
8	.4	.3	.4	.3	.2	.15	2.5	.6	4.8	1.65	1.2	1.6
9	.4	.3	.4	.3	.2	1.1	1.65	.5	4.1	1.5	1.25	1.65
10	.4	.4	.4	.3	.2	1.1	1.45	.4	3.9	1.55	1.25	1.8
11	.4	.45	.4	.3	.2	.9	1.3	.3	3.7	1.5	1.3	1.9
12	.55	.45	.4	.3	.2	1.0	1.05	.35	3.75	1.45	1.3	1.75
13	.6	.4	.5	.25	.2	1.1	.9	.3	2.8	1.45	1.5	1.85
14	.6	.4	.6	.2	.2	1.15	1.3	.15	3.95	1.45	1.5	1.85
15	.6	.6	.6	.2	.1	3.05	.85	.4	4.4	1.3	1.6	1.8
16	.6	.9	.6	.15	.15	2.8	.8	1.05	3.5	1.3	1.35	2.05
17	.6	.9	.6	.15	.15	2.2	.8	1.0	2.9	1.3	1.55	2.15
18	.6	.9	.6	.15	.15	2.25	.8	.9	2.55	1.25	1.5	2.15
19	.6	.9	.6	.15	.15	1.75	.65	2.15	2.25	1.15	1.45	2.1
20	.55	.9	.5	.2	.2	1.4	.6	3.9	2.15	1.25	1.4	2.0
21	.55	.9	.5	.2	.2	1.2	.6	5.25	2.0	1.2	1.55	1.9
22	.55	.8	.4	.25	.15	1.4	.6	2.7	1.95	1.25	1.75	2.0
23	.6	.65	.4	.25	.15	1.75	3.25	1.35	1.75	1.25	1.8	2.2
24	.6	.5	.55	.25	.2	1.7	2.75	2.2	1.3	1.2	1.6	2.15
25	.5	.5	.6	.25	.25	1.7	2.1	2.1	1.6	1.1	1.55	2.05
26	.5	.5	.55	.25	.2	1.45	1.5	1.9	1.35	1.15	1.55	2.05
27	.5	.4	.5	.25	.2	1.1	2.2	2.05	1.7	1.2	1.4	2.15
28	.5	.4	.5	.3	.15	1.0	1.6	1.65	1.75	1.15	1.45	1.85
29	.5	......	.5	.35	.15	1.0	1.85	1.4	1.65	1.15	1.6	2.15
30	.5	......	.5	.3	.15	1.0	1.35	1.15	1.55	1.15	1.6	2.15
31	.5	......	.5	......	.15	......	1.15	.9	......	1.2	......	2.2

GRAPE CREEK AND DE WESSE-DYE DITCH NEAR CANON CITY, COLO.

This station was established July 24, 1907, primarily to determine the amount of flood waters available for storage. Two gages have been used, which have been called the upper and the lower gages. The lower gage was established because of its accessibility. It is located about 150 yards above the junction of the creek with Arkansas River, some distance below the head of the De Wesse-Dye ditch, which has a capacity of about 25 second-feet. The upper gage is located about 1½ miles above the mouth of the stream, and 200 yards above the headgates of the De Wesse-Dye ditch. At high water discharge measurements are made at the upper gage from a car and cable equipment and the discharge of the De Wesse-Dye ditch is subtracted to show the flow past the lower gage.

No important tributaries enter below the upper gage. Pine Creek enters a few miles above.

Considerable irrigation is practiced above this station in the vicinity of Silver Cliff, and a storage reservoir is also used to regulate the supply of water for the De Wesse-Dye ditch.

No change has been made in the datum of either gage since the station was established. During 1909 the lower gage was not used but gage readings were made by means of a Friez automatic gage at the same datum and near the location of the upper rod gage.

High velocities, the character of the stream bed, and the shifting nature of the channel during flood make it difficult to obtain accurate measurements. Moreover, the stream is subject to very rapid rises and subsides just as suddenly, so that an automatic register is necessary to record the changes in the gage heights.

The flow is usually very small during the winter months except when a flood occurs, so that ice conditions have very little influence on the flow. The drainage area at the mouth is 545 square miles, the elevation ranging from 14,000 feet above sea level at headwaters to 5,500 feet at the mouth.

Discharge measurements of Grape Creek near Canon City, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 6 [a]	W. B. Freeman	24	11	0.60	23
June 28	do				[c] 42.5
July 21 [a]	G. H. Russell	18.6	11	1.0	31
August 21 [a]	do	15.5	7.2	.90	21.7
September 18	do	23	29	3.0	232
October 14 [a]	do	14	9.8	1.2	30.9
November 4 [a]	Chatfield and Grieve	16.5	12.4	1.08	38.9
November 24	G. H. Russell	24	25.5	2.15	121
December 22 [b]	do	10	12	1.20	19

[a] Made by wading.

[b] Ice effect. Wading measurement.

[c] Discharge obtained by separate measurements of Grape Creek and De Wesse-Dye ditch.

Daily gage height, in feet, of Grape Creek, near Canon City, Colo., for 1909.

[R. L. Proctor, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1								
2								
3								
4				0.92			1.08	
5				.92				
6	0.60			.92				
7				.91				
8				1.10				
9								
10				.80				
11								
12								
13								
14						1.20		
15								
16								
17								
18					3.00			
19								
20								
21			1.00	.90				
22			1.00					1.20
23			1.02					
24			.98				2.15	
25			.98					
26			.96					
27			.95					
28			.94					
29			.95					
30								
31								

PURGATORY RIVER DRAINAGE BASIN.

DESCRIPTION.

Purgatory[1] River, the principal tributary of Arkansas River in Colorado, rises in the Culebra Mountains and flows northeastward across the plains for a distance of 165 miles. In the spring the channel carries a moderate volume of water, but as summer approaches this is greatly diminished by irrigation and natural conditions until the channel is practically dry. The volume of water contributed to the Arkansas is so small that it has no appreciable effect on the discharge of that river except at times of excessive rainfall, when it may discharge a large volume for a short time.

The drainage basin of Purgatory River is long and narrow. The total area is 3,400 square miles. The 742 square miles lying above Trinidad are mountainous and the surface is much broken by stream channels, which are normally dry. The lower basin is foothill country, merging into rough plains farther east. Drainage lines are well defined throughout part of the area. For 60 miles of its length, commencing 25 miles below Trinidad, Purgatory River flows in a deep canyon. Many small tributary canyons enter at various angles to the main channel.

---

[1] This stream is often termed Las Animas, especially along its lower course, and sometimes it is called Picket Wire. It is sometimes spelled Purgatoire.

In the mountainous portion the Weather Bureau records at Clearview for fifteen years give a mean annual rainfall of 23 inches; at Trinidad, ten years' record, 17 inches. The plains drainage has approximately a mean annual precipitation of 12 inches.

No storage is practiced on this stream, though investigations are being made by a corporation with the purpose of constructing a large storage reservoir for use in irrigation. No power has been developed, and because of the abundance of coal in the vicinity of Trinidad it is doubtful if power development would be feasible, even under very favorable circumstances.

The basin contains about 100 square miles of merchantable timber land and a small amount of woodland, all of which is included in the Las Animas National Forest.

Some 20,000 acres of land are now being irrigated along Purgatory River.

PURGATORY RIVER AT TRINIDAD, COLO.

This station has been maintained at the Animas Street Bridge, Trinidad, Colo., from May 1, 1896, to July 31, 1899; from August 25, 1905, to December 31, 1905; from November 7, 1906, to March 10, 1907; and from October 14, 1907, to date.

The records furnish information as to flood discharge and are valuable also for irrigation projects.

The South Fork joins the upper Purgatory about 14 miles above Trinidad. Chaquaqua River, the first important tributary below, enters about 60 miles below Trinidad. Considerable water is being diverted for irrigation above the station and some below. No power has yet been developed from this stream.

The flow at this point is affected to some extent by ice conditions, though the winter discharge is usually small.

The datum of the present chain gage, which has been used since August 25, 1905, is 1.70 feet below the datum of the old rod gage formerly used. The chain gage is located on the upstream side of the Animas Street Bridge.

Low-water measurements are usually made by wading. Measurements at higher stages are made from the bridge, where conditions are not favorable. The stream bed is shifting in character.

Discharge measurements of Purgatory River at Trinidad, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 1 [a]	G. J. Lyon	33	27.4	4.40	47
May 22 [a]	do	55	50.4	4.70	151
June 28 [a]	do	49.5	48.3	4.80	167
July 23 [b]	Lyon and Russell	56	59	3.60	181
August 24	G. H. Russell	68	88	4.55	402
September 8	C. L. Chatfield	48	80	4.45	373
September 16 [a]	G. H. Russell	67	55	3.80	153
October 20 [a]	do	30	30	3.40	50.5
October 29 [a]	W. B. Freeman	27.8	25.8	3.35	37.3
November 25 [a]	G. H. Russell	20.4	28	3.35	34
December 9 [c]	do	25	33	3.65	28.7

[a] Made by wading.
[b] Measurement not accurate, owing to poor conditions.
[c] Made by wading. Ice conditions.

Daily gage height, in feet, of Purgatory River at Trinidad, Colo., for 1909.

[H. D. Albertson, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		4.7	4.65	3.8	3.8	3.55	3.3	3.4
2		4.65	4.6	3.7	3.8	3.55	3.3	3.4
3		4.7	6.4	3.7	3.85	3.5	3.3	3.4
4		4.7	4.75	4.7	4.0	3.5	3.3	3.45
5		4.8	6.3	3.85	5.4	3.5	3.3	3.45
6		4.8	5.15	3.8	8.0	3.5	3.3	3.4
7		4.85	5.2	4.9	5.25	3.5	3.3	3.5
8		4.9	5.7	3.75	4.4	3.5	3.3	3.85
9	4.5	4.9	6.0	3.35	6.3	3.5	3.3	3.8
10	4.5	4.95	4.75	4.4	4.1	3.5	3.3	3.55
11	4.65	5.0	4.0	4.5	4.35	3.5	3.3	3.65
12	4.65	5.0	4.0	4.8	4.4	3.45	3.3	3.65
13	4.6	5.0	4.45	5.2	4.3	3.45	3.4	3.65
14	4.6	5.0	4.1	5.0	4.1	3.4	3.4	3.65
15	4.65	4.9	5.45	5.1	3.95	3.4	3.4	3.6
16	4.6	4.8	4.8	4.85	3.85	3.4	3.4	3.6
17	4.5	4.8	4.6	7.4	3.8	3.4	3.4	3.6
18	4.5	4.8	4.6	5.0	3.8	3.4	3.4	3.6
19	4.5	4.85	4.7	8.0	3.7	3.4	3.4	3.6
20	4.65	4.9	4.5	4.5	3.8	3.4	3.4	3.6
21	4.75	4.85	5.9	4.0	3.8	3.4	3.4	3.6
22	4.7	4.8	5.25	4.0	3.75	3.4	3.4	3.6
23	4.7	4.7	5.0	3.9	3.7	3.4	3.35	3.6
24	4.65	4.7	6.4	4.8	3.65	3.4	3.35	3.65
25	4.7	5.4	5.0	4.1	3.6	3.35	3.35	3.7
26	4.7	4.8	4.8	4.75	3.6	3.35	3.3	3.85
27	4.6	4.75	4.6	4.0	3.6	3.35	3.3	4.0
28	4.6	4.8	4.5	3.9	3.6	3.35	3.3	4.1
29	4.7	5.7	4.3	3.9	3.6	3.3	3.35	4.0
30	4.7	4.8	4.1	3.8	3.55	3.3	3.35	4.0
31	4.7		4.0	3.85		3.3		4.2

PURGATORY RIVER NEAR HIGBEE, COLO.

For a few months during 1909 daily gage heights were taken on Purgatory River by F. H. Whiting, an engineer for the Bent-Prowers irrigation district, about 1 mile below the district reservoir site.

The rod gage is in sec. 27, T. 25 S., R. 53 W.. 8 or 9 miles below Higbee.

Daily gage height, in feet, of Purgatory River near Higbee, Colo., for 1909.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	......	0.45	1.8	1.6	11	1.85	3.0	1.1	4.95	21	1.4	1.1	4.25	1.6
2	......	.35	1.8	1.7	12	2.3	2.95	1.1	4.3	22	.9	6.9	3.4	1.0
3	......	.3	1.8	1.35	13	4.15	4.2	1.35	6.45	23	.9	3.1	2.15	1.75
4	......	.55	2.6	2.85	14	2.5	2.2	4.0	5.95	24	.95	2.3	1.65	1.2
5	0.2	2.2	2.6	3.65	15	4.3	2.35	3.95	4.3	25	1.4	2.2	2.3	1.6
6	.2	1.65	1.8	4.15	16	2.3	3.5	3.7	3.8	26	1.35	3.5	3.0	1.75
7	.2	2.3	1.6	5.5	17	1.95	2.3	3.4	2.45	27	1.15	3.1	1.65	1.25
8	.2	1.45	1.45	6.05	18	2.45	2.2	8.95	1.75	28	1.55	2.2	1.8	1.45
9	.1	1.35	1.05	5.3	19	2.0	2.1	6.4	1.25	29	.55	1.95	2.85	1.45
10	.1	1.35	1.15	4.45	20	1.55	1.65	7.65	1.35	30	.2	3.0	3.2	1.25
										31	......	2.4	3.0	......

PURGATORY RIVER NEAR LAS ANIMAS, COLO.

This station was originally established May 22, 1889, and discontinued September 3, 1889. A number of miscellaneous discharge measurements were made in 1903.

On August 4, 1909, a chain gage was installed by the state engineer's office at the Atchison, Topeka & Santa Fe Railway bridge which crosses the river a short distance above its mouth. As but few gage heights and low-water measurements were obtained the data are inadequate to make estimates of the daily discharge.

Discharge measurements of Purgatory River near Las Animas, Colo., in 1909.

Date.	Hydrographer.	Area of section.	Gage height.	Discharge.
		Sq. ft.	*Feet.*	*Sec.-ft.*
July 31	Thos. Grieve	70	5.90	131
August 3	do	51	5.89	107
November 10	C. L. Chatfield	23.2	5.80	25.5

NOTE.—Measurements made by wading.

Daily gage height, in feet, of Purgatory River near Las Animas, Colo., for 1909.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1	......	6.4	8.7	11	5.9	9.7	......	21	7.8	9.7	......
2	......	6.4	8.3	12	5.7	9.6	......	22	6.8	9.6	......
3	......	6.5	8.4	13	5.5	9.4	......	23	6.3	9.4	......
4	6.0	6.7	8.2	14	6.0	9.9	......	24	6.0	9.4	......
5	5.8	7.0	7.9	15	7.0	9.9	......	25	6.4	9.2	......
6	6.1	8.0	7.5	16	6.8	10.1	......	26	6.4	9.1	......
7	5.9	9.9	7.1	17	6.5	10.3	......	27	6.5	8.9	......
8	5.9	11.9	6.9	18	7.5	10.3	......	28	6.5	8.4	......
9	5.8	9.9	6.7	19	8.65	9.9	......	29	7.1	8.4	......
10	5.9	10.3	......	20	10.2	9.7	......	30	6.5	8.8	......
								31	6.5	......	......

CANADIAN RIVER DRAINAGE BASIN.

DESCRIPTION.

Canadian River (frequently called Red River in New Mexico) rises in the Cimarron Mountains in Colfax County, N. Mex., flows southward across Mora and San Miguel counties, then turns and flows eastward across northern Texas and through Oklahoma, uniting with Arkansas River about 80 miles above Fort Smith, Ark. The total length of the river from Raton Pass, N. Mex., to the mouth is about 750 miles. Altitudes within the basin range from about 9,000 feet at the head to 460 feet at the mouth. Some of the highest peaks in the Cimarron Range are more than 12,000 feet in elevation.

Cimarron, Mora, and Sapello rivers and Ute Creek, all in New Mexico, are the principal perennial tributaries, but many of the intermittent tributaries, such as the Sweetwater, carry large quantities of flood water. The total drainage of the river in New Mexico is about 13,000 square miles. The North Fork of the Cimarron (frequently called Beaver Creek at its head) is the most important of the lower tributaries. Its drainage area lies just south of the Cimarron (Dry). Along the headwaters of the Canadian in New Mexico is a considerable area of timber land and woodland, and the drainage area in eastern Oklahoma is also wooded. The remainder of the area in New Mexico, Texas, and Oklahoma consists of dry plains.

The annual precipitation varies from 20 inches or more in the mountainous sections to 12 inches or less on the plains of New Mexico and Texas; in Oklahoma the range is from 20 inches in the western part to 35 inches near the mouth of the stream. Except along the lower course the run-off is very uncertain and the river bed is frequently dry for long periods; at other times it carries very disastrous floods. The winters along this stream are mild and the stream flow is rarely affected by ice conditions, except at the higher altitudes.

Many tracts of land are irrigated along the upper Canadian and tributaries, although the aggregate area is only a few thousand acres; the number and acreage of these tracts are, however, rapidly being increased. Good storage sites are afforded by a number of natural lakes and basins, and reservoirs will eventually be constructed on the Cimarron, Vermejo, Ute Creek, Sapello, Mora, and other tributaries, which will provide for the irrigation of hundreds of thousands of acres.

Owing to the intermittent character of the stream, opportunities for water-power development are not very good except on the upper reaches of the mountain streams, but these opportunities will be somewhat increased by storage reservoirs. It may eventually be possible to develop commercially over 25,000 horsepower in New Mexico. At present no important water-power plants are in operation.

CANADIAN RIVER AT LOGAN, N. MEX.

This station, which was reestablished December 22, 1908, for the purpose of determining the amount of water available for storage and irrigation, is located at the Chicago, Rock Island & Pacific Railway bridge, 1 mile south of the depot at Logan, N. Mex. It is near the location of the bridge and gage used by the United States Reclamation Service from June 29, 1904, to February 26, 1905, which were washed out by flood, but the present gage has no determined relation to that gage.

The station is about 5 miles below the mouth of Ute Creek and 3 miles above the mouth of Arroyo Largo. The drainage area is about 12,000 square miles.

The stream flow is not affected by ice and very little by artificial control above. The extremely shifting nature of the stream bed makes it necessary to obtain a large number of discharge measurements in order to obtain the best results. It is usually difficult to make discharge measurements at higher stages on account of the sudden rise and equally rapid subsidence of the river during floods. High-water measurements must be made by floats, because of a large amount of drift in the river. Low-water measurements are made by wading, and those at ordinary stages from a cable 450 feet upstream from the railroad bridge, which is 140 feet high.

Numerous rod gages, secured to old piling under the bridge, were used during 1909, but all gage readings have been referred to the datum of the two railroad gages, which are at the same datum and are painted on the third concrete pier from each bank.

The records have been maintained in cooperation with the territorial engineer of New Mexico.

Discharge measurements of Canadian River at Logan, N. Mex., in 1908-9.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1908.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
November 3[a]					32.5
December 22[a]	J. B. Stewart			3.79	43
1909.					
January 26	J. B. Stewart	26.5	15.7	3.57	10.2
April 12	do				(b)
May 31	do	35	22	3.72	21
June 29	do	142	126	4.22	249
July 21	W. H. Sutton	43	42	3.52	24.4
August 22	do	270	408	5.62	1,850
September 6[c]	J. B. Stewart	410	4,660	16.0	69,900
Do.[c]	do	415	5,380	18.0	87,700
Do.[c]	do	428	6,640	21.0	111,000
Do.[c]	do	438	7,930	24.0	141,000
October 22	W. B. Freeman	91	101	3.48	150
December 4	G. H. Russell	58	67	3.20	69

[a] Published in Water-Supply Paper 247 as miscellaneous.
[b] Stream dry.
[c] Flood measurement by floats.

Daily gage height, in feet, of Canadian River at Logan, N. Mex., for 1908–9.

[R. L. Smith, observer.]

Day.	Dec.	Day.	Dec.
1908.		1908.	
25	3.85	29	3.75
26	3.85	30	3.75
27	3.75	31	3.65
28	3.75		

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	3.65	3.6		2.95		3.7	3.4	4.3	3.6			
2	3.65	3.6		3.0		3.7	3.3	4.3	3.4			
3	3.65	3.6		3.05		3.7	3.3	4.3				
4	3.65	3.6		3.0		3.7	3.2	4.3				3.2
5	3.66	3.55		2.95		3.7	3.5	4.2	6.2			3.7
6	3.65	3.55		2.9		3.7	3.4	4.8	14.0			3.65
7	3.65	3.5		2.85		3.7	3.4	4.4	10.1			3.65
8	3.65	3.45				3.6	3.3	4.3	6.1			3.65
9	3.65	3.35				3.4	3.5	4.4	5.1			3.8
10	3.65	3.25				3.2	5.1	4.4	5.3			3.85
11	3.65	3.15				3.1	4.6	4.3	4.45			3.85
12	3.65	3.05				6.4	4.0	4.3	5.25			3.85
13	3.65	2.95				6.2	3.8	4.4	5.7			3.85
14	3.65	2.9				6.5	3.6	5.4	4.5			3.9
15	3.75	2.85				6.5	4.6	5.4	4.95			3.95
16	3.75	2.8				6.4	4.1	4.3				4.0
17	3.75	2.8				6.2	4.0	3.95				4.3
18	3.75	2.8				6.0	3.9	4.3				4.3
19	3.75	2.75				5.9	3.7	5.0				4.25
20	3.65	2.75				5.8	3.6	6.95				4.25
21	3.65	2.75				5.6	3.5	6.65				4.25
22	3.65	2.7				5.4	3.5	5.6				4.25
23	3.65	2.7			3.6	5.3	3.4	5.25				4.25
24	3.6				3.6	5.3	4.7	3.85				4.25
25	3.6				4.6	5.6	4.7	3.65				4.25
26	3.6				4.4	5.5	4.6	3.6				4.25
27	3.6				4.2	5.1	4.6	3.6				4.25
28	3.6				4.0	4.6	4.5	3.6				4.25
29	3.6				4.0	4.15	4.4	3.7				4.25
30	3.6				3.8	3.7	4.4	4.4				4.25
31	3.6				3.8		4.3	4.25				4.25

NOTE.—River dry February 20 to April 1, 1909; April 8 to May 23, 1909; September 3 to 4, 1909. Gage heights September 16 to December 3, 1909, too unreliable to publish.

Daily discharge, in second-feet, of Canadian River at Logan, N. Mex., for 1908–9.

Day.	Dec.	Day.	Dec.
1908.		1908.	
25	58	29	35
26	58	30	35
27	35	31	20
28	35		

Daily discharge, in second-feet, of Canadian River at Logan, N. Mex., 1908–9—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	20	14	......	0.4	......	26	13	290	38	......	......	......
2	20	14	......	.6	......	26	7	290	13	......	......	......
3	20	14	......	.8	......	26	7	290	0	......	......	......
4	20	14	......	.6	......	26	2	290	0	......	......	69
5	20	11.9	......	.4	......	26	23	240	3,800	......	......	155
6	20	11.9	......	.3	......	26	13	650	53,200	......	......	145
7	20	7.8	......	.2	......	26	13	350	26,200	......	......	145
8	20	6.2	......	......	......	14	7	290	3,350	......	......	145
9	20	3.7	......	......	......	4.5	23	350	1,840	......	......	178
10	20	2.4	......	......	......	1.8	980	350	2,300	......	......	190
11	20	1.4	......	......	......	1.0	480	290	810	......	......	190
12	20	0.8	......	......	......	4,700	155	290	2,170	......	......	190
13	20	.4	......	......	......	3,800	85	350	3,800	......	......	190
14	20	.3	......	......	......	5,150	38	1,420	870	......	......	202
15	35	.2	......	......	......	5,150	480	1,420	1,550	......	......	216
16	35	.1	......	......	......	4,700	195	290	......	......	......	230
17	35	.1	......	......	......	3,800	155	138	......	......	......	330
18	35	.1	......	......	......	2,950	120	290	......	......	......	330
19	35	.1	......	......	......	2,600	58	860	......	......	......	315
20	20	......	......	......	......	2,300	38	7,300	......	......	......	315
21	20	......	......	......	......	1,800	23	5,820	......	......	......	315
22	20	......	......	......	......	1,420	23	1,800	......	......	......	315
23	20	......	......	......	14	1,260	13	1,180	......	......	......	315
24	14	......	......	......	14	1,260	560	102	......	......	......	315
25	14	......	......	......	480	1,800	560	48	......	......	......	315
26	14	......	......	......	335	1,600	480	38	......	......	......	315
27	14	......	......	......	210	980	480	38	......	......	......	315
28	14	......	......	......	110	480	410	38	......	......	......	315
29	14	......	......	......	110	218	350	58	......	......	......	315
30	14	......	......	......	44	58	350	350	......	......	......	315
31	14	......	......	......	44	......	290	265	......	......	......	315

NOTE.—These discharges are based on rating curves applicable as follows: December 25, 1908, to June 11, 1909, fairly well defined between 8 and 110 second-feet; June 12 to September 8, 1909, well defined; September 9 to 15, 1909, indirect method for shifting channels; September 16 to December 3, 1909, no estimates on account of uncertain gage heights; December 4 to 31, 1909, well defined. River dry February 20 to April 1, April 8 to May 23, and September 3 to 4, 1909.

Monthly discharge of Canadian River at Logan, N. Mex., for 1908–9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1908.					
December 25–31	58	20	39.4	547	B.
1909.					
January	35	14	20.9	1,290	B.
February	14	0	3.63	202	C.
March	0	0	0	0	
April	8	0	.11	7	C.
May	480	0	43.9	2,700	C.
June	5,150	1.0	1,540	91,600	B.
July	980	2	207	12,700	B.
August	7,300	38	831	51,100	B.
September 1–15	53,200	0	6,660	198,000	C.
December 4–31	330	69	250	13,900	B.
The period	......	......	......	371,000	

CIMARRON RIVER AT UTE PARK, N. MEX.

This station, which was established July 14, 1907, to determine the amount of water available for storage and irrigation, is located at the highway bridge 300 feet north of the railway station at Ute Park, N. Mex., the terminus of the St. Louis, Rocky Mountain & Pacific Railway. It has been maintained in cooperation with the Territorial engineer of New Mexico.

The station is one-half mile below the mouth of Ute Creek and is below most of the mountain tributaries except the Rayado, which enters several miles below. The drainage area above the station is over 200 square miles.

Very little water is diverted above this point, but most of the normal flow of the stream is used for irrigation in the valley below. The Eagles Nest reservoir site, which has a capacity of over 100,000 acre-feet, is situated in the canyon a few miles upstream from this station and is capable of storing the entire run-off.

Ice is found on this stream during the winter months, but usually has very little effect on the open-channel flow.

The rod-gage datum has remained constant since the station was established. In September, 1909, a Frieze automatic gage was installed at the same location and datum. High-water measurements are made at the bridge and low-water measurements by wading. The stream bed is fairly permanent, but it is rather rough, making high-water measurements somewhat inaccurate. Results, however, should be very good.

Discharge measurements of Cimarron River at Ute Park, N. Mex., in 1908-9.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
1908.					
April 26[a]	R. L. Cooper	36	39	1.10	117
1909.					
January 24	J. B. Stewart	19.5	13	0.43	14.2
April 10	do	24.5	27	.65	35
Do	do	25.5	19.4	.65	40
May 27	do	27	23.6	.70	58
Do	do	28	24.6	.70	54
June 28	do	18.5	10.8	.40	11.8
July 24	W. H. Sutton	20	14.4	.50	21.8
August 28	C. D. Miller	24	28	.65	45
October 13	do	22	19.1	.45	24.4
October 24	W. B. Freeman	21	15.6	.40	17.1
November 27	G. H. Russell	8	4	.32	8.7

[a] This measurement is republished here as it was in error as published in the 1907-8 report. On the basis of this change the 1907-8 estimates have been revised.

NOTE.—Measurements made by wading at various sections.

Daily gage height, in feet, of Cimarron River at Ute Park, N. Mex., for 1909.

[Mrs. R. P. Woodard, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.4	0.35	0.45	0.6	0.85	0.9	0.4	0.2	0.6	0.35	0.3	0.4
2	.4	.35	.45	.6	.85	.9	.4	.3	.6	.35	.3	.4
3	.4	.45	.5	.6	.9	.8	.4	.4	.6	.4	.3	.4
4	.4	.45	.5	.6	1.05	.8	.4	.3	.5	.4	.3	.35
5	.3	.5	.5	.6	1.1	.6	.4	.3	1.0	.4	.3	.3
6	.3	.5	.55	.6	1.1	.6	.3	.3	.8	.4	.3	.3
7	.3	.5	.8	.6	1.1	.6	.3	.3	.7	.45	.3	.3
8	.3	.5	.7	.6	1.15	.6	.3	.3	.7	.45	.3	.3
9	.3	.5	.6	.5	1.1	.6	.3	.3	.7	.45	.3	.35
10	.3	.5	.5	.6	1.1	.6	.3	.35	.6	.45	.3	.35
11	.3	.5	.45	.7	1.1	.6	.3	.4	.6	.45	.3	.35
12	.3	.5	.4	.55	1.0	.6	.3	.4	.6	.45	.3	.4
13	.3	.45	.4	.6	1.0	.6	.3	.4	.6	.45	.3	.4
14	.4	.45	.45	.7	1.0	.6	.3	.4	.6	.4	.3	.4
15	.4	.45	.45	.75	1.0	.6	.3	.6	.55	.45	.3	.45
16	.5	.4	.45	.8	1.0	.6	.3	.6	.5	.45	.3	.5
17	.5	.4	.55	.9	1.0	.6	.3	.7	.5	.45	.3	.5
18	.5	.4	.7	1.0	1.0	.6	.2	.7	.5	.45	.3	.5
19	.5	.4	.85	1.0	1.0	.6	.2	.6	.45	.45	.3	......
20	.5	.45	.6	1.0	1.0	.4	.2	.6	.45	.4	.3	......
21	.4	.45	.6	.95	1.2	.3	.2	.6	.45	.4	.3	......
22	.4	.4	.6	.9	1.0	.3	.2	.9	.4	.4	.3	......
23	.4	.4	.55	1.0	1.0	.3	.3	.7	.4	.4	.3	......
24	.45	.4	.55	.9	1.0	.3	.5	.7	.4	.35	.3	......
25	.45	.45	.55	.9	1.0	.3	.3	.7	.4	.35	.3	......
26	.45	.45	.6	.9	1.0	.3	.2	.7	.4	.35	.3	......
27	.45	.45	.6	.9	.85	.4	.2	.7	.4	.3	.3	......
28	.4	.45	.6	1.0	.7	.4	.2	.7	.4	.3	.3	......
29	.3	......	.7	1.1	.6	.4	.2	.7	.4	.3	.2	......
30	.3	......	.7	.9	1.0	.4	.2	.7	.4	.3	3	......
31	.3	......	.7	......	.9	......	.2	.7	......	.3	......	......

Daily discharge, in second-feet, of Cimarron River at Ute Park, N. Mex., for 1907–1909.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.							1907.						
1	......	32	59	14	14	14	16	22	22	14	14	22	9
2	......	32	44	14	14	14	17	22	14	14	14	14	9
3	......	44	44	14	14	9	18	22	22	14	14	14	9
4	......	44	32	14	14	9	19	22	14	14	14	14	9
5	......	32	22	14	14	9	20	22	32	14	14	14	9
6	......	22	22	14	14	14	21	22	22	14	14	22	9
7	......	22	22	32	14	14	22	32	22	14	14	18	14
8	......	22	22	32	14	14	23	32	22	14	14	14	14
9	......	22	22	22	14	14	24	22	22	14	14	14	14
10	......	22	22	22	14	14	25	22	22	14	14	9	14
11	......	22	22	14	14	14	26	22	22	14	14	22	14
12	......	32	22	14	14	14	27	22	22	14	14	14	14
13	......	32	22	14	32	14	28	44	32	14	14	14	14
14	22	44	22	14	32	9	29	32	32	14	14	14	14
15	22	32	22	14	22	9	30	22	44	14	14	9	14
							31	32	44	......	14	......	14

Daily discharge, in second-feet, of Cimarron River at Ute Park, N. Mex., for 1907–1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	14	22	14	22	96	77	14	22	9	9	22	7
2	14	22	14	22	96	44	14	22	9	9	22	10
3	14	22	14	22	117	44	14	22	9	6	14	10
4	22	22	14	22	117	44	14	14	14	6	14	10
5	14	22	14	22	117	44	14	14	14	6	14	10
6	14	22	14	22	117	44	14	14	9	6	14	15
7	14	14	14	22	96	44	14	22	9	6	13	15
8	14	14	14	22	77	44	22	22	9	6	13	15
9	14	14	14	22	77	44	22	22	9	6	13	8
10	14	14	14	32	77	44	14	22	9	6	13	8
11	14	14	14	14	96	44	14	14	6	6	13	8
12	14	14	14	59	96	44	14	14	6	6	13	8
13	14	14	14	86	96	44	14	14	6	6	13	4
14	14	14	14	96	96	32	14	22	6	6	13	4
15	14	14	32	184	77	32	14	22	9	6	13	7
16	14	22	32	196	77	32	22	14	9	6	8	7
17	14	22	32	184	96	22	22	14	9	6	5	12
18	14	14	32	184	96	22	22	14	9	6	5	12
19	14	14	32	161	96	22	22	14	9	6	5	12
20	14	14	32	161	96	14	22	22	9	6	5	8
21	14	14	32	161	96	14	22	22	9	6	7	8
22	14	14	32	139	77	9	14	22	6	6	7	8
23	14	14	32	161	77	9	14	14	6	6	7	8
24	14	9	32	161	77	9	14	14	9	6	7	8
25	14	9	32	161	96	9	9	22	9	6	7	8
26	14	9	32	117	77	14	14	22	9	6	7	8
27	14	9	32	117	77	14	14	22	9	9	7	13
28	14	9	32	117	77	14	14	22	9	9	7	13
29	14	9	32	96	96	14	14	22	9	14	7	13
30	22	....	32	96	96	14	22	14	9	14	7	9
31	22	....	22	....	77	....	22	14	....	14	....	9
1909.												
1	9.5	10	16	31	86	104	12	6	35	13	10	16
2	9.5	10	16	31	86	104	12	8	35	13	10	16
3	9.5	16	20	31	99	77	12	13	35	16	10	16
4	9.5	16	21	31	139	77	12	8	21	16	10	13
5	7.2	20	21	31	153	35	12	8	130	16	10	10
6	7.2	20	25	31	153	35	8	8	78	16	10	10
7	7.2	20	55	31	154	35	8	8	56	22	10	10
8	7.2	20	42	31	167	35	8	8	56	22	10	10
9	7.6	20	30	21	154	35	8	8	57	22	10	13
10	7.6	20	20	31	154	35	8	10	38	22	10	13
11	7.6	20	16	46	155	35	8	13	38	22	10	13
12	7.6	20	13	23	127	35	8	13	38	22	10	16
13	8	16	13	30	127	35	8	13	39	22	10	16
14	11	16	16	47	127	34	8	13	39	16	10	16
15	11	16	17	58	128	34	8	36	30	22	10	16
16	19	13	17	70	128	34	8	36	25	22	10	16
17	19	13	25	94	128	34	8	55	25	22	10	16
18	19	13	43	121	128	34	6	55	25	22	10	16
19	19	13	64	122	128	34	6	36	20	22	10	16
20	19	16	31	122	129	12	6	36	20	16	10	16
21	12	16	31	109	182	7	6	36	20	16	10	16
22	12	13	31	96	129	7	6	102	15	16	10	16
23	12	13	26	123	129	7	8	55	15	16	10	16
24	16	13	26	96	130	7	22	55	15	13	10	16
25	16	16	26	96	130	7	8	55	15	13	10	16
26	16	16	31	97	131	7	6	55	15	13	10	16
27	16	16	31	97	91	12	6	55	16	10	10	16
28	12	16	31	124	55	12	6	55	16	10	10	16
29	8	....	43	151	36	12	6	53	16	10	6.5	16
30	8	....	43	98	130	12	6	53	16	10	10	16
31	8	....	43	....	104	....	6	53	....	10	....	16

NOTE.—These discharges were obtained as follows: July 14, 1907, to November 2, 1908, based on a rating curve which is fairly well defined; November 3, 1908, to September 30, 1909, indirect method for shifting channels; October 1 to December 14, 1909, based on a rating curve which is not well defined; December 15 to 31, 1909, estimated.

Monthly discharge of Cimarron River at Ute Park, N. Mex., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
July 14–31	44	22	25.4	907
August	44	14	27.9	1,720
September	59	14	21.0	1,250
October	32	14	15.7	965
November	32	9	15.9	946
December	14	9	12.2	750
1908.				
January	22	14	14.8	910
February	22	9	15.2	874
March	32	14	23.5	1,450
April	196	22	96.0	5,710
May	117	77	91.4	5,620
June	77	9	30.0	1,790
July	22	9	16.4	1,010
August	22	14	18.4	1,130
September	14	6	8.73	519
October	14	6	7.16	440
November	22	5	10.5	620
December	15	4	9.52	580
The year	196	4	28.5	20,700
1909.				
January	19	7.2	11.6	713
February	20	10	16.0	889
March	64	13	28.5	1,750
April	151	31	70.7	4,210
May	182	36	126	7,750
June	104	7	32.8	1,950
July	12	6	8.39	516
August	102	6	32.8	2,020
September	130	16	33.3	1,980
October	22	10	16.9	1,040
November	10	6.5	9.88	588
December	16	10	14.8	910
The year	182	6	33.5	24,300

NOTE.—Values for 1907–8 supersede those published in Water Supply Paper 247. Revision was necessary because of an error discovered in computation of discharge measurement of April 26, 1908. Owing to the shifting nature of the stream bed at this station the above values of mean monthly discharge are at best only approximate.

CIMARRON RIVER AT SPRINGER, N. MEX.

This station, which was established July 13, 1907, primarily to determine the amount of unused water in the valley above, is located at Springer, N. Mex., at the highway bridge which crosses the river about one-half mile above the Atchison, Topeka & Santa Fe Railway bridge, about 6 miles below the mouth of the Rayado and 6 miles above its junction with the upper Canadian. The channel is practically without flow during the irrigation season. The drainage area is nearly 1,000 square miles.

The station has been maintained in cooperation with the territorial engineer of New Mexico.

The datum of the rod gage has not been changed. High-water measurements are made from the bridge. The flow is little affected by ice.

On account of the shifting character of the stream and the comparatively small number of discharge measurements the results at this station have not been entirely satisfactory. The station was discontinued December 31, 1909.

Discharge measurements of Cimarron River at Springer, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
January 22	J. B. Stewart	17.5	4.7	0.15	2.6
April 7	do	12	3.3	.10	1.3
May 24	do	51.5	23.8	.68	29
June 26	do	8.4	3	.18	1.7
July 27	W. H. Sutton	6	1.5	−.18	.96
September 14	J. B. Stewart	38	22.5	.74	26
October 14	C. D. Miller	17	6.2	.35	5.8
October 26	W. B. Freeman	14	4.1	.23	3.7
November 28	G. H. Russell	13	8.2	.30	5.3

NOTE.—Measurements are made by wading at various sections.

Daily gage height, in feet, of Cimarron River at Springer, N. Mex., for 1909.

[W. L. Sever, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.6	0.1	0.1	0.1	0.7	0.4	0.15	−0.15	−0.1	0.35	0.2	0.8
2	.5	.4	.1	.1	.65	.3	.15	− .15	− .1	.35	.2	.8
3	.5	.2	.1	.1	.6	.3	.15	− .2	− .1	.35	.2	.8
4	.4	.2	.1	.0	.5	.25	.35	+ .5	− .1	.35	.2	.8
5	.3	.1	.1	.0	.5	.25	.1	− .1	+3.1	.35	.2	.8
6	.5	.0	.0	.1	.65	.25	.2	− .1	1.55	.35	.2	.8
7	.4	.2	.0	.1	.7	.25	.05	− .1	1.5	.35	.2	.8
8	.4	.1	.1	.1	.75	.3	.25	− .1	.9	.35	.2	.8
9	.3	.2	.0	.1	.95	.25	.25	− .1	.9	.3	.2	.8
10	.3	.3	.0	.1	.9	.25	.25	− .1	.6	.3	.2	.8
11	.3	.2	.2	.05	.8	.3	.2	− .1	1.8	.25	.2	.8
12	.3	.0	.4	.05	.6	.8	.2	− .1	.7	.25	.3	.8
13	.3	.0	.4	.0	.5	.4	.2	− .1	.7	.3	.3	.8
14	.3	.2	.4	.05	.5	.35	.2	− .1	.75	.35	.3	.8
15	.2	.2	.3	.1	.5	.35	.2	− .1	.55	.35	.35	.8
16	.2	.1	.3	.1	.4	.35	.2	− .1	.55	.3	.35	.8
17	.2	.1	.1	.1	.4	.25	+ .2	− .1	.5	.25	.3	.8
18	.2	.1	.1	.2	.4	.25	− .1	− .1	.5	.25	.35	.8
19	.2	.2	.1	.25	.4	.25	− .1	+ .2	.45	.3	.3	.8
20	.2	.1	.2	.4	.4	.3	− .1	.25	.4	.25	.3	.8
21	.2	.0	.1	.6	.6	.3	− .1	.0	.4	.25	.3	.8
22	.1	.1	.1	.8	.8	.3	− .1	.1	.4	.25	.3	.8
23	.1	.2	.1	.8	.8	.25	− .1	.1	.4	.2	.3	.8
24	.1	.2	.1	.75	.7	.2	− .1	+ .1	.4	.2	.3	.8
25	.1	.1	.0	.7	.7	.2	− .1	− .1	.3	.2	.3	.8
26	.1	.1	.0	.75	.75	.2	− .1	− .1	.35	.25	.3	.8
27	.1	.1	.0	.7	.8	.2	− .15	− .1	.35	.25	.3	.8
28	.1	.1	.0	.5	.75	.2	− .15	− .1	.35	.25	.3	.8
29	.1	....	.0	.6	.7	.15	− .15	− .1	.35	.25	.8	.8
30	.1	....	.0	.8	.6	.15	− .15	− .1	.35	.25	.8	.8
31	.1	....	.1	....	.5	....	− .15	− .1	....	.2	....	1.3

NOTE.—Ice conditions November 29 to December 31.

Daily discharge, in second-feet, of Cimarron River at Springer, N. Mex., for 1907–1909.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.						1907.					
1	....	66	3.4	3.0	2.7	16	8	5.3	3.2	4.6	2.5
2	....	51	3.4	3.0	2.7	17	5.3	3.4	3.2	4.6	2.5
3	....	66	3.4	3.0	2.7	18	5.3	3.4	3.2	2.8	2.5
4	....	51	3.4	3.0	2.6	19	5.3	3.4	3.2	6.6	2.5
5	....	51	3.4	3.0	2.6	20	5.3	3.4	3.2	4.4	2.5
6	....	31	3.4	3.0	2.6	21	28	3.4	3.2	2.8	2.5
7	....	19	3.4	3.0	2.6	22	19	3.4	3.2	2.8	2.5
8	....	19	3.4	3.0	2.6	23	19	3.4	3.1	2.8	2.5
9	....	12	3.4	3.0	2.6	24	8	3.4	3.1	2.8	2.5
10	....	12	3.4	2.9	2.6	25	8	5.3	4.9	2.8	2.5
11	....	12	3.4	2.9	2.6	26	8	5.3	3.1	2.7	2.5
12	19	12	3.3	4.6	2.5	27	51	5.3	3.1	2.7	2.5
13	12	8	3.3	4.6	2.5	28	166	5.3	3.1	2.7	2.5
14	12	5.3	3.2	4.6	2.5	29	93	3.4	3.1	2.7	2.5
15	8	5.3	3.2	4.6	2.5	30	51	3.4	3.1	2.7	2.5
						31	107	....	3.1	....	2.5

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	3	43	23	19	135	12	1.4	1.4	1.7	1.1	17	5.3
2	3	11	22	12	135	12	1.4	1.4	1.7	1.1	17	5.0
3	3	43	22	8	200	5.2	1.4	1.4	2.9	1.1	17	7.2
4	3	26	22	8	200	3.3	1.4	1.4	1.8	1.1	17	6.9
5	3	25	22	5.2	200	3.3	.9	1.4	1.8	1.1	16	6.6
6	3	10	35	5.2	200	3.3	.9	1.4	1.8	1.2	15	6.3
7	3	16	35	5.2	135	1.4	.9	2.2	1.9	1.2	14	6.1
8	3	25	35	5.2	135	1.4	1.4	2.2	1.9	1.2	9.4	5.9
9	3	16	58	5.2	84	1.4	1.4	1.4	1.2	1.2	8.9	5.6
10	3	10	22	5.2	84	1.4	1.4	1.4	1.2	1.2	8.7	5.4
11	5	16	21	5.2	84	1.4	1.4	2.2	1.2	1.2	8.2	5.1
12	5	16	21	8	84	2.2	1.4	2.2	1.2	1.3	12	4.9
13	5	16	21	19	84	2.2	1.4	1.4	1.2	1.3	12	7.2
14	5	39	21	51	84	2.2	1.4	232	1.2	1.3	11	4.5
15	5	39	21	135	84	2.2	4.2	13	1.2	1.4	11	2.9
16	5	39	21	135	84	2.2	2.2	5 4	1.3	1.4	10	2.8
17	5	39	21	232	84	2.2	1.4	1.4	1.3	1.4	6.4	1.6
18	5	39	33	265	84	2.2	1.4	1.4	1.3	1.5	5.9	2.6
19	5	39	33	200	51	1.4	1.4	1.4	1.5	1.5	5 6	6.1
20	5	39	32	200	31	1.4	1.4	5.8	1.5	1.5	5.3	6.0
21	10	64	44	232	31	1.4	1.4	14	1.5	1.5	5.1	6.2
22	10	37	32	200	31	1.4	1.4	11	1.0	6.0	4.9	6.2
23	10	23	32	232	135	1.4	1.4	9.1	1.0	9.6	3.0	4.1
24	10	23	20	232	135	1.4	1.4	9.1	1.0	9.6	2.9	4.3
25	17	23	20	265	84	1.4	3.3	6.0	1.0	9.6	2.8	4.5
26	17	23	19	200	84	6.6	1.4	6.2	1.0	9.9	2.7	26
27	17	23	19	200	84	3.3	1.4	4.0	1.1	9.9	2.6	11
28	16	14	19	135	51	2.2	1.4	2.6	1.1	9.9	14	7.3
29	16	23	19	135	31	1.4	1.4	2.7	1.1	16	5.6	4.8
30	16	....	31	135	19	1.4	25	2.7	1.1	16	5.4	5.0
31	16	....	19	....	19	....	5.2	1.6	....	16	....	7.6
1909.												
1	12	2.2	2.2	2.2	31	8.0	2.8	0.8	0.9	5.6	3.3	5.0
2	7.8	8.0	2.2	2.2	25	5.2	2.8	.8	.9	5.6	3.3	5.0
3	8.2	3.3	2.2	2.2	19	5.2	2.8	.6	.9	5.6	3.3	5.0
4	5.6	3.3	2.2	1.4	12	4.2	6.6	12	.9	5.8	3.3	5.0
5	3.7	2.2	2.2	1.4	12	4.2	2.2	.9	800	5.8	3.3	5.0
6	9.0	1.4	1.4	2.2	25	4.2	3.3	.9	490	5.8	3.3	5.0
7	5.8	3.3	1.4	2.2	31	4.2	1.8	.9	455	5.8	3.3	5.0
8	5.8	2.2	2.2	2.2	41	5.2	4.2	.9	77	6.0	3.3	5.0
9	3.9	3.3	1.4	2.2	110	4.2	4.2	.9	74	4.9	3.3	5.0
10	3.9	5.2	1.4	2.2	84	4.2	4.2	.9	16	4.9	3.3	5.0
11	3.9	3.3	3.3	1.8	51	5.2	3.3	.9	500	4.0	3.3	5.0
12	4.1	1.4	8.0	1.8	19	51	3.3	.9	24	4.1	5.2	5.0
13	4.1	1.4	8.0	1.4	12	8.0	3.3	.9	22	5.1	5.2	5.0
14	4.1	3.3	8.0	1.8	12	6.6	3.3	.9	27	6.4	5.2	5.0
15	2.8	3.3	5.2	2.2	12	6.6	3.3	.9	11	6.6	6.6	5.0

Daily discharge, in second-feet, of Cimarron River at Springer, N. Mex., for 1907–1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
16	2.8	2.2	5.2	2.2	8.0	6.6	3.3	.9	11	5.2	6.6	5.0
17	2.9	2.2	2.2	2.2	8.0	4.2	3.3	.9	8.9	4.2	5.2	5.0
18	2.9	2.2	2.2	3.3	8.0	4.2	.9	.9	9.4	4.2	6.6	5.0
19	3.0	3.3	2.2	4.2	8.0	4.2	.9	3.3	7.6	5.2	5.2	5.0
20	3.0	2.2	3.3	8.0	8.0	5.2	.9	4.2	6.1	4.2	5.2	5.0
21	3.1	1.4	2.2	19	19	5.2	.9	1.4	6.1	4.2	5.2	5.0
22	2.0	2.2	2.2	51	51	5.2	.9	2.2	6.4	4.2	5.2	5.0
23	2.2	3.3	2.2	51	51	4.2	.9	2.2	6.4	3.3	5.2	5.0
24	2.2	3.3	2.2	41	31	3.3	.9	2.2	6.4	3.3	5.2	5.0
25	2.2	2.2	1.4	31	31	3.3	.9	.9	4.1	3.3	5.2	5.0
26	2.2	2.2	1.4	41	41	3.3	.9	.9	5.4	4.2	5.2	5.0
27	2.2	2.2	1.4	31	51	3.3	.8	.9	5.4	4.2	5.2	5.0
28	2.2	2.2	1.4	12	41	3.3	.8	.9	5.4	4.2	5.2	5.0
29	2.2	....	1.4	19	31	2.8	.8	.9	5.4	4.2	5.0	5.0
30	2.2	....	1.4	51	19	2.8	.8	.9	5.6	4.2	5.0	5.0
31	2.2	....	2.2	....	12	....	.8	.9	....	3.3	....	5.0

NOTE.—These discharges were obtained as follows: March 29 to August 14, 1908; January 23 to September 4, 1909, and October 1 to November 28 from a rating curve which is well defined below 30 second-feet; August 12 to December 16, 1907; January 25 to March 28, 1908; August 15 to January 22, 1909, and September 6 to 30, 1909, indirect method for shifting channels; December 17, 1907, to January 24, 1908; September 5, 1909, and November 22 to December 31, 1909, estimated.

Monthly discharge of Cimarron River at Springer, N. Mex., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
August 12-31	166	5.3	31.9	1,270	C.
September	66	3.4	16.0	952	C.
October	4.9	3.1	3.31	204	C.
November	6.6	2.7	3.39	202	C.
December	2.7	2.5	2.55	157	D.
1908.					
January	17	....	7.6	467	D.
February	64	10	27.6	1,590	C.
March	58	19	26.3	1,620	C.
April	265	5.2	110	6,550	B.
May	200	19	95.7	5,880	B.
June	12	1.4	2.87	171	C.
July	25	.9	2.41	148	C.
August	232	1.4	11.3	695	C.
September	2.9	1.0	1.39	83	C.
October	16	1.1	4.49	276	C.
November	17	2.6	9.21	548	C.
December	26	1.6	6.16	379	C.
The year	265	.9	25.4	18,400	
1909.					
January	12	2.0	4.01	247	C.
February	8.0	1.4	2.79	155	B.
March	8.0	1.4	2.77	170	B.
April	51	1.4	13.2	786	B.
May	110	8.0	29.5	1,810	B.
June	51	2.8	6.24	371	B.
July	6.6	.8	2.26	139	B.
August	12	.6	1.57	97	C.
September	[a] 800	.9	86.6	5,150	B.
October	6.6	3.3	4.76	293	B.
November	6.6	3.3	4.63	276	B.
December	....	....	5.0	307	C.
The period	....	....	13.6	9,800	

[a] Estimated.

RAYADO RIVER AT ABREU'S RANCH, NEAR CIMARRON, N. MEX.

This station, which was established during the first part of 1908 as a temporary station by the New Mexico Hydrographic Survey to determine the amount of water available for irrigation, is located three-fourths of a mile upstream from Abreu's ranch, which is 20 miles west of Springer and 12 miles southwest of Cimarron, the two nearest railroad points. Daily gage readings were taken during 1909 by the Territorial Survey. In October, 1909, when the United States Geological Survey abandoned the station on the Rayado at Miami ranch, near Springer, it took over the station at Abreu's ranch.

The station is now maintained in cooperation with the territorial engineer of New Mexico.

The river receives no tributaries for several miles above or below the station, and the station is above all irrigation diversions.

The datum and location of the gage has remained constant during the maintenance of the station. On November 27, 1909, a chain gage was installed at the same location and datum as the rod gage.

Measurements of discharge are made by wading in the vicinity of the gage or from a foot log about 100 yards upstream. Fair results should be obtained. Thin ice is sometimes found at the station during the winter months.

Discharge measurements of Rayado River at Abreu's ranch, near Cimarron, N. Mex., in 1908-9.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1908.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
August 10[a]	R. L. Cooper	22.5	11.7	1.25	6.1
October 31[a]	do	21	7.3	1.15	3
1909.					
January 23	J. B. Stewart	11.2	7.3	1.20	4.2
April 9	do	15.5	9.1	1.33	9.6
May 25	do	15.5	16.7	1.55	20.5
June 27	do	12	6.6	1.25	4.8
July 26	W. H. Sutton	14	14.7	1.20	3.8
August 3	do	12	7.0	1.22	4.1
August 7	do	12	7.9	1.24	4.4
August 9	do	13	6.2	1.19	3.7
August 11	do	12.5	7.2	1.26	4.8
August 12	do	12.5	8.4	1.37	9.4
August 13	do	12	6.1	1.20	3.8
August 15	do	13	9.9	1.45	13.6
August 16	do	12.3	7.2	1.30	5.5
August 18	do	14.3	18.3	1.95	73
August 19	do	13.0	8.8	1.35	9.4
August 20	C. D. Miller	12.5	8.0	1.36	10.1
August 21	do	13.0	9.7	1.41	13.9
Do	do	13.0	9.6	1.41	13.7
August 24	do	13.0	10.9	1.50	18.7
August 26	do	13.0	11.1	1.50	18.7
September 26	J. B. Stewart			1.50	[b] 20.0
October 14	C. D. Miller	13.0	7.5	1.20	5.1
October 25	W. B. Freeman	12.5	6.2	1.25	4.3
November 26	G. H. Russell	12.5	7.6	1.30	5.8

[a] Published in Water Supply Paper 247 as miscellaneous.

[b] Estimated.

Daily gage height, in feet, of Rayado River at Abreu's ranch, near Cimarron, N. Mex., for 1909.

[W. W. Dougan, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				1.3	1.6		1.3	1.2	1.35	1.2	1.30	1.29
2						1.45			1.5	1.2	1.26	1.30
3	1.25		1.3		1.5		1.3	1.28	1.4	1.2	1.28	1.30
4		1.20	1.3	1.4		1.45		1.36	1.5	1.22	1.30	1.32
5	1.25				1.6		1.35	1.69	1.9	1.25	1.29	1.33
6				1.3		1.4		1.30	1.8	1.25	1.30	1.33
7	1.15		1.25		1.6		1.52	1.22	1.7	1.3	1.30	1.30
8				1.3		1.4		1.2	1.65	1.28	1.27	1.32
9		1.2			1.7		1.3	1.2	1.6	1.28	1.29	1.34
10			1.25	1.35		1.4	1.25	1.2	1.9	1.28	1.30	1.35
11					1.6			1.26	1.7	1.26	1.30	1.38
12	1.2					1.4	1.2	1.21	1.5	1.26	1.28	1.40
13					1.6			1.20	1.45	1.30	1.27	1.31
14	1.2	1.2	1.25	1.35		1.4	1.2	1.22	1.4	1.30	1.28	1.36
15					1.6	1.4		1.45	1.35	1.28	1.30	
16							1.25	1.29	1.35	1.30	1.27	
17				1.70	1.55	1.3		1.25	1.3	1.32	1.30	1.70
18		1.3					1.2	1.64	1.28	1.34	1.30	1.70
19				1.80	1.6	1.3		1.35	1.28	1.32	1.29	1.72
20	1.2						1.2		1.3	1.3	1.30	1.73
21		1.3	1.3	1.50	1.55	1.3			1.28	1.3	1.30	1.75
22							1.2	1.40	1.25	1.3	1.30	1.78
23	1.2				1.5	1.3			1.25	1.3	1.28	1.79
24	1.2	1.3	1.3	1.5		1.25	1.25	1.52	1.2	1.28	1.29	1.80
25	1.2				1.52			1.50	1.2	1.28	1.29	1.82
26				1.5		1.25	1.25	1.5	1.18	1.30	1.30	1.35
27					1.5	1.25		1.45	1.18	1.32	1.30	1.35
28		1.3	1.3	1.55			1.2	1.4	1.16	1.30	1.30	1.40
29				1.55	1.45	1.25		1.4	1.20	1.30	1.28	1.41
30							1.2	1.4	1.22	1.28	1.27	1.38
31	1.35				1.5		1.3	1.4		1.32		1.40

NOTE.—Ice conditions January 1 to about February 28, December 4 and December 17 to 25. December 4 reading to top of ice 2 inches thick. December 17 to 25 readings to top of ice 3 to 4 inches thick.

Daily discharge, in second-feet, of Rayado River at Abreu's ranch, near Cimarron, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.2	3.8	6.7	6.7	28	18	6.7	3.8	9.4	3.8	6.7	6.4
2	5.2	3.8	6.7	8.5	24	16	6.7	5.0	19	3.8	5.5	6.7
3	5.2	3.8	6.7	10.2	19	16	6.7	6.1	12	3.8	6.1	6.7
4	5.2	3.8	6.7	12	24	16	8.0	9.9	19	4.4	6.7	6.0
5	5.2	3.8	6.2	9.4	28	14	9.4	38	66	5.2	6.4	8.3
6	4.2	3.8	5.7	6.7	28	12	15	6.7	52	5.2	6.7	8.3
7	3.2	3.8	5.2	6.7	28	12	21	4.4	39	6.7	6.7	6.7
8	3.3	3.8	5.2	6.7	34	12	14	3.8	34	6.1	5.8	7.8
9	3.4	3.8	5.2	8.0	39	12	6.7	3.8	28	6.1	6.4	8.8
10	3.5	3.8	5.2	9.4	34	12	5.2	3.8	66	6.1	6.7	9.4
11	3.7	3.8	5.2	9.4	28	12	4.5	5.5	39	5.5	6.7	10.9
12	3.8	3.8	5.2	9.4	28	12	3.8	4.1	19	5.5	6.1	12
13	3.8	3.8	5.2	9.4	28	12	3.8	3.8	16	6.7	5.8	7.2
14	3.8	3.8	5.2	9.4	28	12	3.8	4.4	12	6.7	6.1	9.9
15	3.8	4.0	5.4	19	28	12	4.5	16	9.4	6.1	6.7	8.0
16	3.8	4.8	5.6	29	26	9.4	5.2	6.4	9.4	6.7	5.8	6
17	3.8	5.7	5.8	39	24	6.7	4.5	5.2	6.7	7.8	6.7	6
18	3.8	6.7	6.1	46	26	6.7	3.8	32	6.1	8.8	6.7	6
19	3.8	6.7	6.3	52	28	6.7	3.8	9.4	6.1	7.8	6.4	7
20	3.8	6.7	6.5	36	26	6.7	3.8	10.3	6.7	6.7	6.7	7
21	3.8	6.7	6.7	19	24	6.7	3.8	11.1	6.1	6.7	6.7	7
22	3.8	6.7	6.7	19	22	6.7	3.8	12	5.2	6.7	6.7	8
23	3.8	6.7	6.7	19	19	6.7	4.5	16	5.2	6.7	6.1	8
24	3.8	6.7	6.7	19	20	5.2	5.2	21	3.8	6.1	6.4	8
25	3.8	6.7	6.7	19	21	5.2	5.2	19	3.8	6.1	6.4	8

Daily discharge, in second-feet, of Rayado River at Abreu's ranch, near Cimarron, N. Mex., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
26	3.8	6.7	6.7	19	20	5.2	5.2	19	3.6	6.7	6.7	9.4
27	3.8	6.7	6.7	22	19	5.2	4.5	16	3.6	7.8	6.7	9.4
28	3.8	6.7	6.7	24	18	5.2	3.8	12	3.3	6.7	6.7	12
29	3.8	....	6.7	24	16	5.2	3.8	12	3.8	6.7	6.1	12.7
30	3.8	....	6.7	26	18	6.0	3.8	12	4.4	6.1	5.8	10.9
31	3.8	....	6.7	....	19	....	6.7	12	....	7.8	....	12

NOTE.—These discharges are based on a rating curve which is fairly well defined below 80 second-feet. Periods for which gage heights are missing were obtained by interpolation.

Monthly discharge of Rayado River at Abreu's ranch, near Cimarron, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	5.2	3.2	3.98	245	C.
February	6.7	3.8	5.05	280	C.
March	6.7	5.2	6.12	376	B.
April	52	6.7	18.4	1,090	A.
May	39	16	24.9	1,530	A.
June	18	5.2	9.78	582	A.
July	21	3.8	6.17	379	A.
August	38	3.8	11.1	682	A.
September	66	3.3	17.3	1,030	A.
October	8.8	3.8	6.25	384	A.
November	6.7	5.5	6.39	380	A.
December	12.7	6	8.40	516	C.
The year	66	3.2	10.3	7,470	

RAYADO RIVER NEAR SPRINGER, N. MEX.

This station, which was established July 9, 1907, to obtain data concerning the amount of water available for storage and irrigation, is located at the proposed site of the Farmers Development Company's reservoir dam, and about one-half mile north of their office, which is at Miami ranch, 12 miles west of Springer, the nearest railroad point. The records have been obtained in cooperation with the territorial engineer of New Mexico.

The station is about 6 miles above the junction of the Rayado with Cimarron River, and below the important tributaries. The drainage area is about 100 square miles. Considerable water is diverted for irrigation above this point.

The rod-gage datum has remained permanent since the station was established. Discharge measurements are made by wading. The flow is practically unaffected by ice. The stream bed is fairly permanent, and good results will be obtained when the discharge has been well defined by measurements.

The station was abandoned in October, 1909.

Discharge measurements of Rayado River near Springer, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
January 23	J. B. Stewart	3.4	0.46	0.05	0.29
Do	do	7.2	1.3	.05	.2
April 8	do	14.5	4.0	.29	5.9
May 25	do	12.5	2.9	.22	2.7
July 26	W. H. Sutton			.06	a .2
September 13	J. B. Stewart			.40	a .15
October 14	C. D. Miller			.20	a .5
October 25	W. B. Freeman	8	1.9	.15	1.3

a Estimated.

Daily gage height, in feet, of Rayado River near Springer, N. Mex., for 1909.

[J. W. Ausherman, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.
1	....	....	....	0.25	0.20	0.22	0.08	....
2	....	0.1	0.1	.3	.39	.2	.08	0.10
3	0.1	....	....	.3	.4	.2	.08	.09
4	.1	.1	....	.4	.4	.2	.08	....
5	.1	....	.1	.38	.4	.2	.08	.08
6	.1	....	....	.4	.4	.2	.20	....
7	.1	.1	.1	.3	.39	.2	.09	.08
8	.1	....	....	.3	.40	.2	.08	....
9	....	.1	.1	.28	.42	....	.08	.06
10	.1	....	.1	.3	.40	.11	.08	.06
11	.1	.1	....	.3	.32	.1	....	.06
12	....	....	.1	.31	.32	.1	.08	....
13	.1	.1	.1	.44	.31	.12	.10	.08
14	.1	....	....	.32	.29	....	.08	.08
15	.1	....	.1	.36	.30	.1	.05	.08
16	.1	....	.1	.4	.32	.1	.05	.08
17	....	....	.15	.51	.3	.1	.05	....
18	.1	.1	.15	.6	.3	.09	.08	....
19	.1	....	.2	.61	.14	.09	.08	....
20	.1	.1	.15	.5	....	.09	.08	....
21	.1	....	.15	.48	.3	.1	.08	....
22	.1	.1	.2	.4	.3	....	.10	....
23	....	.1	.2	.25	.24	.09	.08	....
24	.1	....	....	.2	....	....	.08	....
25	.1	.1	.15	.29	.3	.09	.08	....
26	....	....	.15	.33	.22	.09	.08	....
27	.1	.1	.15	.30	.2	.09	.06	....
28	....	....	.15	.31	.2	.08	....	....
29	.1	....	....	.33	.2	.08	.06	.12
30	....	....	.15	.29	.2	....	....	....
21	.1	....	....	....	.2	....	.06	....

Daily discharge, in second-feet, of Rayado River near Springer, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	0.4	0.4	0.4	3.8	1.8	2.6	0.4	0.4
2	.4	.4	.4	5.8	10	1.8	.4	.4
3	.4	.4	.4	5.8	11	1.8	.4	.4
4	.4	.4	.4	11	11	1.8	.4	.4
5	.4	.4	.4	10	11	1.8	.4	.4
6	.4	.4	.4	11	11	1.8	1.8	.4
7	.4	.4	.4	5.8	10	1.8	.4	.4
8	.4	.4	.4	5.8	11	1.8	.4	.4
9	.4	.4	.4	5.0	12	1.2	.4	.3
10	.4	.4	.4	5.8	11	.5	.4	.3
11	.4	.4	.4	5.8	6.8	.4	.4	.3
12	.4	.4	.4	6.3	6.8	.4	.4	.4
13	.4	.4	.4	13	6.3	.6	.4	.4
14	.4	.4	.4	6.8	5.4	.5	.4	.4
15	.4	.4	.4	8.9	5.8	.4	.3	.4
16	.4	.4	.4	11	6.8	.4	.3	.4
17	.4	.4	.8	18	5.8	.4	.3	.4
18	.4	.4	.8	25	5.8	.4	.4	.4
19	.4	.4	1.8	26	.7	.4	.4	.5
20	.4	.4	.8	17	3.2	.4	.4	.5
21	.4	.4	.8	16	5.8	.4	.4	.5
22	.4	.4	1.8	11	5.8	.4	.4	.5
23	.4	.4	1.8	3.8	3.4	.4	.4	.5
24	.4	.4	1.3	1.8	4.6	.4	.4	.5
25	.4	.4	.8	5.4	5.8	.4	.4	.5
26	.4	.4	.8	7.4	2.6	.4	.4	.6
27	.4	.4	.8	5.8	1.8	.4	.3	.6
28	.4	.4	.8	6.3	1.8	.4	.3	.6
29	.4	....	.8	7.4	1.8	.4	.3	.6
30	.4	....	.8	5.4	1.8	.4	.3	.6
31	.4	....	2.3	....	1.8	....	.3	.6

NOTE.—The above discharges are based on a well-defined rating curve. The periods for which gage heights are missing are interpolated.

Monthly discharge of Rayado River near Springer, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	0.4	0.4	0.4	25	C.
February	.4	.4	.4	22	C.
March	2.3	.4	.75	46	B.
April	26	1.8	9.26	551	A.
May	12	.7	6.14	378	A.
June	2.6	.4	.84	50	B.
July	1.8	.3	.42	26	B.
August	.6	.3	.45	28	C.
The period	....	....	....	1,130	

MORA RIVER AND LA CUEVA CANAL AT LA CUEVA, N. MEX.

This station, which was established August 25, 1903, primarily to determine the amount of water available for storage, is located at the wagon bridge at La Cueva, N. Mex., in the Mora land grant, 26 miles north of Las Vegas, N. Mex. Since July, 1907, the records have been obtained in cooperation with the territorial engineer of New Mexico.

The station is a few miles above the mouth of the Cebolla and a short distance downstream from the intake of La Cueva Canal, and just below the canal waste way. This canal carries water for irrigation, and during the nonirrigating season it is used as a feeder for a reservoir below.

The canal rod gage is located at a footbridge below the wasteway, just north of the gaging station on the river. The datum of the canal gage has remained constant and gage readings have been taken continuously since the station was established whenever there was any water in the canal. Apparent discrepancies in the gagings of the canal are accounted for by the fact that the bed of the canal occasionally contains a considerable deposit of silt, which is cleaned out at intervals.

A little water is diverted above the station for irrigation in addition to that taken out by La Cueva canal, and considerable land is irrigated below the station. By developing the available storage at reservoir sites in that locality it will be possible to utilize the entire flow of the stream for irrigation.

The original gage was washed out in the flood of September 29, 1904, and was replaced by another at practically the same section on April 29, 1905. The datum of this staff gage, which is still in use, is 1.32 feet above that of the original gage.

Fair measurements can be made by wading at low stages; high-water measurements must be corrected for the skew of the bridge. The channel is subject to some shifting, but fair results should be obtained by making frequent measurements at the higher stages.

Discharge measurements of Mora River at La Cueva, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
January 21	J. B. Stewart	17.7	11.8	0.64	11.8
April 6	do	15.5	9.4	.60	8.6
Do	do	16.5	11.9	.60	8.5
May 23	do	21	23.7	1.12	48
June 25	do	18	14.5	.69	17
July 29	W. H. Sutton	10	4.0	.42	2.7
August 28	do	26	42	2.20	111
October 27	W. B. Freeman	17	15.6	1.11	15
November 30	G. H. Russell	19	15.8	1.08	15.6

Daily gage height, in feet, of Mora River at La Cueva, N. Mex., for 1909.

[Hugh Loudon, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		0.65	0.6	0.5	0.7	1.0	1.05	0.4	1.6	1.15	1.15	1.0
2		.65	.6	.5	.85	.9	.95	.4	1.45	1.15	1.15	1.05
3		.55	.6	.65	.8	.9	.8	1.7	1.45	1.15	1.1	......
4		.5	.6	.5	.95	.9	1.25	1.2	1.4	1.15	1.05	1.1
5		.7	.45	.5	.9	1.0	1.4	1.05	3.45	1.2	1.05	1.15

Daily gage height, in feet, of Mora River at La Cueva, N. Mex., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
6	0.65	0.65	0.4	0.5	1.05	1.3	1.5	1.0	3.7	1.2	1.0	1.15
7	.6	.6	.5	.6	1.10	1.1	1.4	.9	3.0	1.2	1.05	1.15
8	.5	.6	.5	.5	1.15	1.1	1.2	1.95	2.55	1.2	1.05	1.05
9	.5	.6	.5	.5	1.1	1.0	1.15	1.0	2.3	1.3	1.1	1.1
10	.35	.6	.6	.65	1.0	1.0	1.0	1.3	2.2	1.3	1.05	1.05
11	.3	.65	1.8	.55	.95	1.1	.95	1.3	2.1	1.3	1.05	1.1
12	.65	.6	.7	.55	1.0	1.2	.75	1.2	2.0	1.25	....	1.15
13	.7	.6	.7	.6	.8	1.15	.6	2.3	1.9	1.25	1.05	1.1
14	.6	.65	.7	.45	.75	1.10	.6	1.35	1.8	1.2	1.05	1.05
15	.6	.8	.65	.4	.8	1.05	.6	2.3	1.7	1.1	1.1	1.1
16	.6	.6	.7	.45	.9	.9	.55	1.3	1.65	1.2	1.1	1.1
17	.6	.6	.7	.5	.75	.9	.5	1.2	1.6	1.2	1.0	1.05
18	.6	.65	.65	.6	.7	.9	.5	1.15	1.6	1.3	.8	......
19	.6	.65	.65	.9	.75	1.4	.5	2.55	1.55	1.25	1.1	......
20	.6	.6	.65	.8	1.2	1.6	.5	1.8	1.5	1.25	1.05	......
21	.6	.6	....	.7	1.05	1.2	.45	1.75	1.45	1.2	1.1	......
22	.65	.7	.70	.75	1.1	1.15	.5	1.45	1.3	....	1.0	......
23	.6	.8	.65	.75	1.1	.9	.6	2.8	1.3	....	1.05	......
24	.6	.65	.6	.8	1.05	.7	.5	2.4	1.3	1.2	1.05	......
25	.6	.6	.6	.7	1.05	.7	.7	3.15	1.3	1.2	1.05	......
26	.5	.6	.7	.7	1.05	.7	.8	2.8	1.25	1.2	1.0	......
27	.6	.6	.7	.65	1.05	.7	.75	2.55	1.25	1.1	1.0	......
28	.6	.6	.7	.7	1.0	.55	.45	2.2	1.2	1.15	....	......
29	.8	....	.7	.9	1.05	.5	.5	2.1	1.2	1.15	1.1	......
30	.8	....	.7	.8	1.1	1.1	.5	1.95	1.2	1.05	1.1	......
31	.75	....	.5	....	1.05	....	.4	1.7	1.15	1.1	....	......

NOTE.—Possible ice effect at times during January, February, and March, which did not materially affect the flow. Ice jam March 11. River frozen December 18 to 31.

Daily discharge, in second-feet, of Mora River at La Cueva, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10	12	10	5.5	15	38	42	1.5	49	18	18	10
2	10	12	10	5.5	26	29	34	.9	35	18	18	12
3	10	7.8	10	12	22	29	22	106	35	18	15	14
4	10	5.5	10	5.5	34	29	62	52	32	18	12	15
5	10	15	3.8	5.5	29	38	79	36	268	22	12	18
6	12	12	2.0	5.5	42	68	91	31	320	22	10	18
7	10	10	5.5	10	47	47	79	22	211	22	12	18
8	5.5	10	5.5	5.5	52	47	57	125	155	22	12	12
9	5.5	10	5.5	5.5	47	38	52	26	125	29	15	15
10	1.0	10	10	12	38	38	38	51	115	29	12	12
11	0	12	12	7.8	34	47	34	49	120	29	12	15
12	12	10	15	7.8	38	57	18	38	92	26	12	18
13	15	10	15	10	22	52	10	156	82	26	12	15
14	10	12	15	3.8	18	47	10	49	71	22	12	12
15	10	22	12	2.0	22	42	10	151	61	15	15	15
16	10	10	15	3.8	29	29	7.8	41	58	22	15	15
17	10	10	15	5.5	18	29	5.5	31	53	22	10	12
18	10	12	12	10	15	29	5.5	18	53	29	2.5	8
19	10	12	12	29	18	79	5.5	172	48	26	15	8
20	10	10	12	22	57	103	5.5	83	43	26	12	8
21	10	10	14	15	42	57	3.8	76	39	22	15	8
22	12	15	15	18	47	52	5.5	44	27	22	10	8
23	10	22	12	18	47	29	10	194	27	22	12	8
24	10	12	10	22	42	15	5.5	143	27	22	12	8
25	10	10	10	15	42	15	15	234	27	22	12	8
26	5.5	10	15	15	42	15	22	188	25	22	10	8
27	10	10	15	12	42	15	18	155	25	15	10	8
28	10	10	15	15	38	7.8	3.8	111	22	18	12	8
29	22	....	15	29	42	5.5	5.5	100	22	18	15	8
30	22	....	15	22	47	47	5.5	84	18	12	15	8
31	18	....	5.5	....	42	....	2.0	58	....	15	....	8

NOTE.—These discharges are based on curves applicable as follows: January 1 to 5, estimated; January 6 to July 31, well defined below 57 second-feet; August 1 to September 27, indirect method for shifting channels; September 28 to December 17, not well defined; December 18 to 31, estimated on account of ice conditions; March 11 and all other days for which there are no gage heights, interpolated.

Monthly discharge of Mora River at La Cueva, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	22	0	10.3	633	C.
February	22	5.5	11.5	639	A.
March	15	2.0	11.3	695	A.
April	29	2.0	11.8	702	A.
May	57	15	35.4	2,180	A.
June	103	5.5	39.1	2,330	B.
July	91	2.0	24.7	1,520	B.
August	234	.9	84.7	5,210	C.
September	320	18	76.2	4,530	C.
October	29	12	21.6	1,330	B.
November	18	2.5	12.6	750	B.
December	18	....	11.5	707	C.
The year	320	0	29.2	21,200	

Discharge measurements of La Cueva canal at La Cueva, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
April 6	J. B. Stewart	8.3	9.1	0.55	6.5
May 23	.....do	8.7	9.7	.85	11.0
July 29	W. H. Sutton	11.5	6.5	.50	6.6
August 28	.....do	8.5	9.6	1.10	10.5
October 27	W. B. Freeman	7.6	7.2	.82	6.6

Daily gage height, in feet, of La Cueva canal at La Cueva, N. Mex., for 1909.

[Hugh Loudon, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.3	0.05	0.05	0.5	0.9	0.9	0.8	0.7	1.2	1.2	0.3	0.7
2	.3	(a)	.05	.5	.75	.8	.95	.45	1.2	1.2	.3	.8
3	.3	.2	.05	.3	.75	.8	.9	1.05	1.2	1.2	.6	......
4	.4	.15	.45	.5	.4	.9	.85	.9	1.2	1.2	.65	.2
5	.4	.1	.55	.5	.9	.85	.95	.9	(a)	1.2	.65	(a)
6	(a)	(a)	.2	.55	.55	.3	(a)	.85	(a)	1.25	.65	.5
7	(a)	(a)	.25	.5	.6	.8	.9	.9	(a)	1.2	.65	.55
8	.4	(a)	.2	.5	.7	.9	.9	1.3	1.0	1.5	.65	.5
9	.3	(a)	(a)	.5	.7	1.05	.85	1.1	1.0	.3	.7	(a)
10	.7	(a)	(a)	.2	1.0	1.05	1.0	1.2	.9	.3	.7	.3
11	.7	(a)	(a)	.5	.85	1.1	.95	(a)	.4	.3	.8	.25
12	.1	(a)	(a)	.5	.9	1.05	.9	(a)	.5	.3	.8	.25
13	(a)	(a)	(a)	.55	.7	1.05	1.2	(a)	.4	.3	.8	(a)
14	.05	(a)	(a)	.75	.8	1.0	.7	(a)	.3	.3	.7	(a)
15	.05	.1	(a)	.6	.85	1.1	.7	(a)	.45	1.1	.7	(a)
16	.05	.1	(a)	.5	.95	1.1	.65	(a)	.35	.25	.2	(a)
17	.05	(a)	(a)	.65	.6	1.1	.6	(a)	.3	.25	.6	(a)
18	.05	.05	.15	.95	.9	1.0	.5	(a)	.25	.3	1.05	(a)
19	.05	.05	.2	1.0	1.15	.9	.5	(a)	.15	.3	.25	(a)
20	.05	.05	.1	.95	.8	1.0	.5	.65	.1	.2	.7	(a)
21	.05	(a)	.1	1.35	.75	.75	.35	.7	(a)	.2	.2	(a)
22	.05	(a)	.15	1.1	.85	.8	.6	1.0	1.2	.2	.9	(a)
23	.05	(a)	.3	1.15	.85	.9	.7	.5	1.25	.2	.7	(a)
24	.05	(a)	.3	.9	.8	.8	.75	(a)	1.3	.2	.55	(a)
25	.05	.1	.3	1.15	.9	.9	.8	(a)	1.3	.2	.55	(a)
26	.05	.05	(a)	1.1	.9	1.2	1.0	.9	1.3	.2	.9	(a)
27	.05	.1	(a)	1.1	.9	1.0	1.0	.9	1.3	.9	.85	(a)
28	.05	.05	(a)	1.15	.8	.9	.6	1.1	1.3	.5	......	(a)
29	.05	......	(a)	1.3	.95	.85	.5	1.15	1.25	.5	.1	(a)
30	(a)	......	(a)	1.25	.9	.8	.5	1.15	1.25	1.0	.2	(a)
31	(a)	......	.5	......	.9	......	.5	1.05	......	.3	......	(a)

[a] Water turned out of canal.

Daily discharge, in second-feet, of La Cueva canal at La Cueva, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.3	1.2	1.2	5.8	12	12	10	8.7	12.5	12.5	1.1	4.8
2	3.3	0	1.2	5.8	9.3	10	13	4.9	12.5	12.5	1.1	6.1
3	3.3	2.4	1.2	3.3	9.3	10	12	14	12.5	12.5	3.6	3.3
4	4.5	2.0	1.2	5.8	4.5	12	11	11	12.5	12.5	4.2	.5
5	4.5	1.6	5.2	5.8	12	11	13	10.7	0	12.5	4.2	0
6	0	0	6.5	6.5	6.5	3.3	0	9.5	0	13.4	4.2	2.6
7	0	0	2.4	5.8	7.2	10	12.2	10	0	12.5	4.2	3.1
8	4.5	0	2.8	5.8	8.6	12	12.2	16.7	9.1	17.9	4.2	2.6
9	3.3	0	2.4	5.8	8.6	15	11.4	12.8	9.1	1.1	4.8	0
10	8.6	0	0	2.4	14	15	14.0	14.2	7.5	1.1	4.8	1.1
11	8.6	0	0	5.8	11	16	13.1	0	1.8	1.1	6.1	.7
12	1.6	0	0	5.8	12	15	12.2	0	2.6	1.1	6.1	.7
13	0	0	0	6.5	8.6	15	23	0	1.8	1.1	6.1	0
14	1.2	0	0	9.3	10	14	9.2	0	1.1	1.1	4.8	0
15	1.2	1.6	0	7.2	11	16	9.2	0	2.2	10.8	4.8	0
16	1.2	1.6	0	5.8	13	16	8.4	0	1.4	.7	.5	0
17	1.2	0	0	7.9	7.2	16	7.6	0	1.1	.7	3.6	0
18	1.2	1.2	2.0	13	12	14	6.4	0	.8	1.1	9.9	0
19	1.2	1.2	2.4	14	17	12	6.4	0	.3	1.1	.7	0
20	1.2	1.2	1.6	13	10	14	6.4	5.4	.1	.5	4.8	0
21	1.2	0	1.6	21	9.3	9.3	4.5	5.8	0	.5	.5	0
22	1.2	0	2.0	16	11	10	7.9	10	12.5	.5	7.5	0
23	1.2	0	3.3	17	11	12	9.6	2.9	13.4	.5	4.8	0
24	1.2	0	3.3	12	10	10	10.4	0	14.3	.5	3.1	0
25	1.2	1.6	3.3	17	12	12	11.3	0	14.3	.5	3.1	0
26	1.2	1.2	0	16	12	18	14.8	7.8	14.3	.5	7.5	0
27	1.2	1.6	0	16	12	14	14.9	7.6	14.3	7.5	6.8	0
28	1.2	1.2	0	17	10	12	8.1	10.5	14.3	2.6	3.4	0
29	1.2	......	0	20	13	11	6.6	11.7	13.4	2.6	.1	0
30	0	......	0	19	12	10	6.4	11.7	13.4	9.1	.5	0
31	0	......	5.8	......	12	......	6.1	9.9	......	1.1	......	0

NOTE.—Discharges January 1 to July 6 are based on a rating curve which is poorly defined. The indirect method for shifting channels is used for the remainder of the year.

Monthly discharge of La Cueva canal at La Cueva, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	8.6	0	2.09	129	C.
February	2.4	0	.70	39	C.
March	6.5	0	1.59	98	C.
April	21	2.4	10.4	619	B.
May	17	4.5	10.6	652	B.
June	18	3.3	12.6	750	B.
July	23	0	10.0	615	C.
August	16.7	0	6.32	389	C.
September	14.3	0	7.30	434	C.
October	17.9	.5	4.96	305	C.
November	9.9	.1	4.04	240	C.
December	6.1	0	.82	50	C.
The year	23	0	5.95	4,320	

SAPELLO RIVER AT LOS ALAMOS, N. MEX.

This station, which was established August 22, 1903, to determine the amount of water available for diversion into the San Guijuella reservoir for the Las Vegas project, is located about 100 yards upstream from the post-office and general store at Los Alamos, N. Mex., 13 miles north of Las Vegas, the nearest railroad point.

The proposed reservoir lies about 6 miles northwest of Las Vegas, has a storage capacity of about 40,000 acre-feet, is to be filled from the Gallinas, Sapello, and other streams in that vicinity, and is to be used for the irrigation of 10,000 acres of land. The station is situated about 4 miles below the mouth of the Manuelitos and a few miles above the junction of the Sapello with Mora River. A considerable portion of the normal flow of the stream is diverted for irrigation above the station.

The original gage was destroyed by a flood on September 29, 1904, and was replaced in April, 1905, by the present chain gage 400 feet upstream, and at a different datum. Results for short periods during the winter season are sometimes affected by ice on this stream.

The channel is somewhat shifting in character, and on account of the inadequacy of discharge measurements, especially at the higher stages, results have not been entirely satisfactory. Discharge measurements are made from cable during high stages and by wading at miscellaneous sections during low stages. Cable is located about 200 feet above chain gage.

Discharge measurements of Sapello River at Los Alamos, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
January 21	J. B. Stewart	9	3.3	−0.25	1.1
April 6	do	8.5	2.9	− .25	1.6
May 23	do	9.2	2.7	− .20	1.4
June 25	do	4.3	.8	− .25	.7
July 29	W. H. Sutton	12	3.8	− .18	1.7
August 28	do	22	24.6	.30	12.5
October 27	W. B. Freeman	8	2.5	− .15	1.2
November 30	G. H. Russell	11	8.9	− .10	1.6

Daily gage height, in feet, of Sapello River at Los Alamos, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	−0.2	−0.3	−0.25	−0.3	−0.25	−0.2	−0.2	−0.2	0.0	−0.1	−0.1	−0.1
2	− .2	− .3	− .25	− .3	− .2	− .2	− .2	− .2	.0	− .1	− .1	− .1
3	− .2	− .3	− .25	− .3	− .2	− .2	− .2	− .2	.0	− .1	− .1	− .1
4	− .2	− .3	− .25	− .3	− .2	− .2	− .25	− .2	.0	− .1	− .1	− .1
5	− .2	− .3	− .25	− .3	− .2	− .2	− .25	− .2	.75	.0	− .1	− .1
6	− .2	− .3	− .25	− .25	− .2	− .2	− .25	− .2	1.6	.0	− .1	− .1
7	− .2	− .3	− .25	− .2	− .2	− .2	.1	− .2	1.4	− .1	− .1	− .1
8	− .2	− .3	− .25	− .2	− .2	.2	.05	− .2	1.15	− .1	− .1	− .1
9	− .2	− .3	− .2	− .2	− .2	− .2	− .1	− .2	.0	− .1	− .1	− .1
10	− .2	− .3	− .2	− .2	− .2	− .2	− .2	.6	.05	− .1	− .1	− .1
11	− .2	− .3	− .2	− .25	− .2	− .2	− .2	.05	.05	− .1	− .1	− .1
12	− .2	− .3	− .3	− .2	− .2	− .2	− .25	− .15	.05	− .1	− .1	− .1
13	− .2	− .3	− .3	− .2	− .2	− .2	1.0	.0	.05	− .1	− .1	− .1
14	− .2	− .3	− .3	− .2	− .2	− .2	.1	− .05	.05	− .1	− .1	− .1
15	− .1	− .25	− .3	− .2	− .2	− .2	− .2	.0	.05	− .1	− .1	− .1
16	− .1	− .3	− .3	− .2	− .2	− .2	1.25	.0	.0	− .1	− .1	− .1
17	− .1	− .3	− .3	− .2	− .2	− .2	− .1	− .15	.0	− .1	− .1	− .1
18	− .1	− .3	− .3	− .2	− .2	− .2	− .2	− .2	.0	− .1	− .1	− .1
19	− .1	− .3	− .3	− .2	− .25	− .2	− .2	.35	.0	− .1	− .1	− .1
20	− .1	− .35	− .3	− .2	− .2	− .2	− .25	.05	− .05	− .1	− .1	− .1

Daily gage height, in feet, of Sapello River at Los Alamos, N. Mex., for 1909—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	−0.25	−0.35	−0.3	−0.2	−0.2	−0.2	−0.2	0.05	−0.1	−0.1	−0.1	−0.15
22	− .25	− .3	− .3	− .2	− .2	− .2	.1	.0	− .1	− .1	− .1	− .2
23	− .25	− .25	− .3	− .25	− .2	− .25	− .2	.05	− .1	− .1	− .1	− .2
24	− .25	− .25	− .3	− .25	− .2	− .25	− .25	.05	− .1	− .15	− .1	− .2
25	− .25	− .25	− .3	− .25	− .2	− .25	− .1	.05	− .1	− .15	− .1	− .2
26	− .25	− .25	− .25	− .25	− .2	− .2	− .2	.05	− .1	− .15	− .1	− .1
27	− .3	− .25	− .3	− .25	− .2	− .2	− .2	.05	− .1	− .15	− .1	− .1
28	− .3	− .25	− .3	− .25	− .2	− .2	− .2	.05	− .1	− .1	− .1	− .1
29	− .3	....	− .3	− .25	− .2	− .2	− .2	.0	− .1	− .1	− .1	− .1
30	− .3	....	− .3	− .25	− .2	− .25	− .2	.0	− .1	− .1	− .1	− .1
31	− .3	....	− .3	....	− .2	....	− .2	.0	....	− .1	....	− .1

Daily discharge, in second-feet, of Sapello River at Los Alamos, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.4	0.7	1.3	1.1	1.2	1.3	1.1	1.5	4.3	2.1	1.7	1.6
2	1.4	.7	1.3	1.1	1.8	1.3	1.1	1.5	4.3	2.1	1.7	1.6
3	1.4	.7	1.3	1.1	1.8	1.3	1.1	1.5	4.2	2.1	1.7	1.6
4	1.5	.7	1.3	1.1	1.8	1.3	.7	1.5	4.2	2.1	1.7	1.6
5	1.5	.7	1.3	1.1	1.8	1.3	.8	1.5	39	3.4	1.7	1.6
6	1.5	.7	1.3	1.6	1.8	1.3	.8	1.5	159	3.4	1.7	1.6
7	1.5	.7	1.3	2.1	1.8	1.2	5.9	1.5	121	2.1	1.7	1.6
8	1.5	.7	1.3	2.1	1.7	1.2	4.8	1.5	77	2.0	1.7	1.6
9	1.5	.7	1.9	2.1	1.7	1.2	2.3	1.5	4.0	2.0	1.7	1.6
10	1.5	.7	1.9	2.1	1.7	1.2	1.2	29	5.0	2.0	1.7	1.6
11	1.5	.7	1.9	1.5	1.7	1.2	1.2	5.3	5.0	2.0	1.7	1.6
12	1.5	.7	.8	2.1	1.7	1.2	.8	2.0	5.0	2.0	1.7	1.6
13	1.6	.7	1.0	2.1	1.7	1.2	72	4.3	4.9	1.9	1.7	1.6
14	1.6	.7	1.0	2.1	1.7	1.2	6.1	3.4	4.9	1.9	1.7	1.6
15	2.8	1.2	1.0	2.1	1.7	1.1	1.3	4.3	4.9	1.9	1.7	1.6
16	2.8	.8	1.0	2.1	1.5	1.1	95	4.3	3.9	1.9	1.6	1.6
17	2.8	.8	1.0	2.1	1.5	1.1	2.4	2.0	3.9	1.9	1.6	1.6
18	2.8	.8	1.0	2.1	1.5	1.1	1.2	1.5	3.8	1.8	1.6	1.6
19	2.8	.8	1.0	2.1	1.0	1.1	1.2	15	3.8	1.8	1.6	1.6
20	2.8	.3	1.0	2.1	1.5	1.1	.8	5.3	2.9	1.8	1.6	1.6
21	1.1	.3	1.0	2.1	1.4	1.1	1.3	5.3	2.3	1.8	1.6	1.1
22	1.2	.8	1.0	2.1	1.4	1.1	1.0	4.3	2.3	1.8	1.6	.6
23	1.2	1.3	1.0	1.3	1.4	.7	1.3	5.3	2.2	1.7	1.6	.6
24	1.2	1.3	1.0	1.3	1.4	.7	.9	5.3	2.2	1.2	1.6	.6
25	1.2	1.3	1.0	1.3	1.4	.7	2.6	5.3	2.2	1.2	1.6	.6
26	.7	1.3	1.5	1.3	1.4	1.1	1.3	5.3	2.2	1.2	1.6	1.6
27	.7	1.3	1.1	1.3	1.4	1.1	1.4	5.3	2.2	1.2	1.6	1.6
28	.7	1.3	1.1	1.3	1.4	1.1	1.4	5.3	2.2	1.7	1.6	1.6
29	.7	....	1.1	1.3	1.3	1.1	1.4	4.3	2.2	1.7	1.6	1.6
30	.7	....	1.1	1.3	1.3	.7	1.5	4.3	2.1	1.7	1.6	1.6
31	.7	....	1.1	....	1.3	....	1.5	4.3	....	1.7	....	1.6

NOTE.—These discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Sapello River at Los Alamos, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	2.8	0.7	1.56	96	C.
February	1.3	.3	.84	47	C.
March	1.9	.8	1.19	73	C.
April	2.1	1.1	1.68	100	C.
May	1.8	1.0	1.54	95	C.
June	1.3	.7	1.11	66	C.
July	95	.7	7.01	431	B.
August	29	1.5	4.65	286	B.
September	159	2.1	16.2	964	B.
October	3.4	1.2	1.91	117	C.
November	1.7	1.6	1.65	98	C.
December	1.6	.6	1.45	89	C.
The year	159	.3	3.40	2,460	

UTE CREEK NEAR LOGAN, N. MEX.

This station, which was reestablished April 13, 1909, to obtain records of the flow available for storage and irrigation, is located 7 miles northwest of Logan, N. Mex., 4 miles above the mouth of Ute Creek, and 100 yards northwest of the old Martinez house. The station is maintained in cooperation with the territorial engineer of New Mexico.

No important tributaries enter Ute Creek below the station or for several miles above. The stream is intermittent in character and most of the run-off water is derived from heavy rains on the basin. A little water is diverted for irrigation above the station, but storage is necessary in order to utilize any considerable proportion of the flow for that purpose. Several reservoir sites are located in that vicinity, the best known of which is probably the Ute Creek reservoir site, a few miles above the gaging station.

Measurements are made by wading near the gage. Estimates of flood discharge have been made by Kutter's formula. To obtain good results it will be necessary to install a cable in the vicinity of the gage. The stream bed is very shifting in character and the creek is subject to sudden rises, so that results obtained will at best be only moderately accurate.

The location and datum of the inclined rod gage has remained constant and is the same as that used by the United States Reclamation Service from August 12, 1904, to June 30, 1906.

Discharge measurements of Ute Creek near Logan, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
April 13	J. B. Stewart			0.50	0.2
July 22	W. H. Sutton				(a)
August 23	do	26	16.4	1.05	27
September 8	J. B. Stewart	96.5	83	2.10	310
October 21	W. B. Freeman	41	15.2	.90	10.4
December 4	G. H. Russell	26	10.2	.80	13.4

[a] Creek dry.

NOTE.—An estimate of the flood of September 6 was made by slope measurement. The maximum gage height was 12.2 feet and discharge 22,900 second-feet.

Daily gage height, in feet, of Ute Creek near Logan, N. Mex., for 1909.

[Eligio Martinez, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1							0.3	0.6
2							.3	.65
3						1.8	.3	.7
4						1.9	.3	.8
5						2.1	.2	.7
6					7.5	2.1	.2	.7
7					3.7	2.1	.2	.7
8					2.4	1.9	.2	.7
9				2.9	1.8	1.8	.2	.7
10				1.7	1.3	1.0	.2	.7
11				1.5	1.05	.85	.2	.7
12				1.5	1.1	.55	.2	.7
13				1.7	.95		.2	.7
14				.75	.7		.3	.7
15		2.3		.2	1.1		.3	.7
16		2.2		1.1	1.4		.3	.7
17		1.7		1.35	1.25	1.85	.3	.7
18		.55		3.15	1.0	1.6	.3	.7
19		.25		2.1	.95	1.0	.3	.6
20		.25		1.7	.55	.9	.3	.6
21	0.75	.25		1.65	.35	.9	.3	.5
22	.55	.25		1.15	.25	.6	.3	.5
23	.2	.4		1.1	.10	.5	.3	.5
24	1.3	.8		1.35		.5	.3	.5
25	.75	2.05		.8		.45	.3	.5
26	.35	3.2		.55		.4	.3	.5
27	.15	1.3		.35		.3	.3	.5
28		1.8		.2		.3	.3	.4
29		1.9		.1		.3	.35	.4
30		2.5		.1		.3	.5	.4
31						.3		.4

Daily discharge, in second-feet, of Ute Creek near Logan, N. Mex., for 1909.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0	0	0	0	0	0	4
2	0	0	0	0	0	0	0	6
3	0	0	0	0	0	196	0	8
4	0	0	0	0	0	232	0	13
5	0	0	0	0	0	310	0	8
6	0	0	0	0	9,500	310	0	8
7	0	0	0	0	1,700	310	0	8
8	0	0	0	0	490	232	0	8
9	0	0	0	890	196	196	0	8
10	0	0	0	164	67	21	0	8
11	0	0	0	110	27	10	0	8
12	0	0	0	110	33	1.1	0	8
13	0	0	0	164	17	0	0	8
14	0	0	0	6.2	4.5	0	0	8
15	0	420	0	0	33	0	0	8
16	0	360	0	33	88	0	0	8
17	0	164	0	78	58	210	0	8
18	0	1.1	0	1,120	21	132	0	8
19	0	0	0	310	17	19	0	5
20	0	0	0	164	1.1	11	0	5
21	6.2	0	0	150	0	10	0	2
22	1.1	0	0	41	0	1	0	2
23	0	0	0	33	0	0	0	2
24	67	8	0	78	0	0	0	2
25	6.2	290	0	8	0	0	0	2
26	0	1,160	0	1.1	0	0	0	2
27	0	67	0	0	0	0	0	2
28	0	196	0	0	0	0	0	1
29	0	232	0	0	0	0	0	1
30	0	560	0	0	0	0	2	1
31	0		0	0		0		1

NOTE.—Discharges May 1 to October 16 are based on a poorly defined rating curve. The indirect method for shifting channels used November 30 to December 31.

Monthly discharge of Ute Creek near Logan, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May	67	0	2.60	160	C.
June	1,160	0	115	6,840	C.
July	0	0	0	0	
August	1,120	0	112	6,890	C.
September	9,500	0	408	24,300	C.
October	310	0	71.0	4,370	C.
November	2	0	.07	4	D.
December	13	1	5.5	338	D.
The period				42,900	

YAZOO RIVER DRAINAGE BASIN.

DESCRIPTION.

Yazoo River is formed by the union of Tallahatchie and Yalobusha rivers just above Greenwood, Miss., whence it flows southward and southwestward to its junction with the Mississippi at Vicksburg.

Tallahatchie River and its large tributary, Coldwater River, rise in the northern part of Mississippi. Yokona River, also an important tributary of the Tallahatchie, comes in from the east just above the mouth of the Coldwater. Yalobusha River rises in the northern part of the State, farther east than the other tributaries. Sunflower River, which empties into the Yazoo about 20 miles above Vicksburg, drains a narrow basin along the upper western border of the State which is cut off from Mississippi River by the levees.

The drainage area may be divided into two distinct parts, the delta and the hill lands. The delta comprises a strip of land east of the Mississippi extending from the state line on the north to Vicksburg on the south, about 60 miles wide at the center and decreasing in width to about 5 miles at either end. The hill lands comprise the portion of the drainage area located to the east of the delta. The entire delta is traversed by many small streams and bayous and contains numerous so-called lakes, which are really old river channels. During high-water periods the natural channels carry water from one stream to another, and large areas are covered by overflow water.

Except for the land that has been cleared for cultivation—at present a relatively small amount—the drainage area is forested. The mean annual precipitation is about 50 inches. Yazoo River is navigable for its entire length, and most of the larger tributaries are navigable for small boats. The tributaries are used to some extent for logging.

The data collected in the drainage basin are of value for drainage and navigation problems. The Tallahatchie drainage commission is engaged in a drainage project in the upper portion of the basin.

TALLAHATCHIE RIVER AT BATESVILLE, MISS.

This station, which is located at the county highway bridge 1 mile west of Batesville and about 2 miles below the crossing of the Illinois Central Railroad, was established on June 15, 1906. The record has been continuous since that time except for a break from August 1 to September 19, 1906. The station is now maintained in connection with the Tallahatchie drainage commission.

The ground on the right bank is low for a mile or more, but the road has been raised above high water except at a number of bridged openings.

Discharge measurements can be conveniently made at all stages and the relation between gage heights and discharge should be fairly constant. A chain gage attached to the bridge is used, the datum of which has remained the same.

Discharge measurements of Tallahatchie River at Batesville, Miss., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 18	Engineers of the Tallahatchie drainage commission	198	2,010	11.90	5,220
February 21	.....do			16.91	[a] 11,200
May 28	.....do	150	1,200	7.68	2,520
June 1	.....do			15.47	[b] 8,850
August 29	E. H. Swett	130	538	2.58	391

[a] Including overflow of 2,030 second-feet.

[b] Including overflow of 1,080 second-feet.

Daily gage height, in feet, of Tallahatchie River at Batesville, Miss., for 1909.

[John S. Goff, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	3.7	16.2	6.8	10.6	15.3	6.4	3.2	2.5	2.8	2.5	2.7
2	3.6	3.8	16.9	6.3	10.0	15.9	6.1	3.5	2.5	2.7	2.5	2.7
3	3.5	3.9	16.7	5.9	9.1	15.3	5.9	3.2	2.5	2.6	2.5	2.7
4	3.6	3.9	16.1	5.6	8.9	15.1	10.7	3.1	2.5	2.6	2.5	2.7
5	3.9	4.0	15.8	5.2	8.6	15.6	11.9	3.1	5.8	2.6	2.5	2.8
6	4.0	4.1	14.3	5.5	8.5	16.7	12.7	3.3	5.4	2.5	2.5	2.7
7	4.2	4.1	13.7	5.9	8.4	16.7	12.6	3.7	4.8	2.5	2.5	5.4
8	4.2	5.0	13.2	5.6	8.4	16.1	11.6	4.4	3.1	2.5	2.5	4.5
9	3.9	5.2	13.3	5.4	8.4	15.2	9.6	3.9	3.2	2.5	2.5	3.7
10	3.6	5.8	13.3	5.2	8.7	14.0	7.4	3.7	3.2	2.4	2.7	3.7
11	3.6	6.0	12.9	5.2	7.0	12.4	5.0	3.3	3.2	2.4	2.7	3.7
12	3.5	6.0	11.6	5.9	5.4	9.9	5.8	3.3	3.1	2.4	2.8	7.1
13	3.5	6.1	12.7	10.6	5.0	7.5	5.7	3.2	3.0	2.4	2.7	6.7
14	3.6	9.2	13.7	10.2	4.7	7.8	5.3	3.2	3.0	2.4	2.5	5.7
15	4.1	12.3	14.0	9.8	4.5	7.9	4.8	3.1	2.9	2.4	2.5	5.2
16	4.6	11.5	13.9	9.9	4.4	8.1	4.5	3.0	2.8	2.4	2.4	5.2
17	5.5	11.2	13.4	10.0	4.2	8.4	4.3	3.0	2.7	2.4	2.4	4.9
18	5.4	11.9	13.1	10.7	4.1	9.5	4.3	3.0	2.6	2.4	2.4	4.5
19	5.3	13.5	13.9	11.2	4.2	9.6	4.4	2.9	2.6	2.4	2.4	4.0
20	5.2	15.6	15.0	13.0	5.5	10.7	4.7	2.9	2.5	2.5	2.5	3.7
21	4.9	16.9	15.3	13.9	5.9	11.9	4.7	2.8	3.4	2.5	2.7	3.4
22	4.9	16.7	14.7	13.6	5.5	12.7	4.3	2.8	4.6	2.5	2.7	3.3
23	4.8	16.3	13.4	12.7	6.0	12.6	4.0	2.8	3.9	2.5	3.1	3.3
24	4.7	16.0	12.4	10.8	6.4	11.6	3.8	2.7	3.6	2.5	2.9	6.8
25	4.7	15.7	10.9	8.0	7.0	9.6	3.4	2.7	3.4	2.5	2.8	7.1
26	4.6	15.3	9.5	7.8	10.6	7.4	3.5	2.7	3.4	2.5	2.8	6.9
27	4.4	14.7	8.4	7.5	8.5	6.9	3.5	2.6	3.3	2.5	2.8	5.3
28	4.1	14.7	8.1	7.3	7.7	6.9	3.4	2.6	3.2	2.4	2.8	5.3
29	3.7	......	7.7	7.2	7.9	6.8	3.3	2.6	3.0	2.4	2.8	5.3
30	3.6	......	7.4	7.4	8.2	6.5	3.3	2.6	2.9	2.4	2.8	5.2
31	3.6	......	7.1	......	14.0	......	3.2	2.5	......	2.5	......	5.2

Daily discharge, in second-feet, of Tallahatchie River at Batesville, Miss., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	849	849	10,100	2,060	4,220	8,760	1,880	679	455	549	455	517
2	815	883	11,100	1,840	3,820	9,610	1,760	781	455	517	455	517
3	781	919	10,800	1,680	3,250	8,760	1,680	679	455	485	455	517
4	815	919	9,910	1,560	3,130	8,500	4,300	645	455	485	455	517
5	919	955	9,460	1,400	2,960	9,180	5,220	645	1,640	485	455	549
6	955	991	7,540	1,520	2,900	10,800	5,920	713	1,480	455	455	517
7	1,030	991	6,890	1,680	2,840	10,800	5,820	849	1,250	455	455	1,480
8	1,030	1,320	6,390	1,560	2,840	9,910	4,980	1,100	645	455	455	1,140
9	919	1,400	6,490	1,480	2,840	8,630	3,560	919	679	455	455	849
10	815	1,640	6,490	1,400	3,010	7,200	2,330	849	679	425	517	849
11	815	1,720	6,100	1,400	2,150	5,640	1,320	713	679	425	517	849
12	781	1,720	4,980	1,680	1,480	3,750	1,640	713	645	425	549	2,200
13	781	1,760	5,920	4,220	1,320	2,380	1,600	679	613	425	517	2,020
14	815	3,310	6,890	3,940	1,210	2,530	1,440	679	613	425	455	1,600
15	991	5,560	7,200	3,680	1,140	2,580	1,250	645	581	425	455	1,400
16	1,170	4,900	7,100	3,750	1,100	2,680	1,140	613	549	425	425	1,400
17	1,520	4,660	6,590	3,820	1,030	2,840	1,060	613	517	425	425	1,290
18	1,480	5,220	6,300	4,300	991	3,490	1,060	613	485	425	425	1,140
19	1,440	6,690	7,100	4,660	1,030	3,560	1,100	581	485	425	425	955
20	1,400	9,180	8,370	6,200	1,520	4,300	1,210	581	455	455	455	849
21	1,290	11,100	8,760	7,100	1,680	5,220	1,210	549	747	455	517	747
22	1,290	10,800	8,000	6,790	1,520	5,920	1,060	549	1,170	455	517	713
23	1,250	10,200	6,590	5,920	1,720	5,820	955	549	919	455	645	713
24	1,210	9,760	5,640	4,360	1,880	4,980	883	517	815	455	581	2,060
25	1,210	9,320	4,440	2,630	2,150	3,560	747	517	747	455	549	2,200
26	1,170	8,760	3,490	2,530	4,220	2,330	781	517	747	455	549	2,100
27	1,100	8,000	2,840	2,380	2,900	2,100	781	485	713	455	549	1,440
28	991	8,000	2,680	2,280	2,480	2,100	747	485	679	425	549	1,440
29	849	....	2,480	2,240	2,580	2,060	713	485	613	425	549	1,440
30	815	....	2,330	2,330	2,740	1,920	713	485	581	425	549	1,400
31	815	....	2,200	....	7,200	....	679	455	....	455	......	1,400

NOTE.—The above daily discharges are based on a rating curve well defined between discharges 500 and 12,000 second-feet.

Monthly discharge of Tallahatchie River at Batesville, Miss., for 1909.

Month.	Discharge, in second-feet.			Accuracy.
	Maximum.	Minimum.	Mean.	
January	1,520	781	1,040	A.
February	11,100	849	4,700	A.
March	11,100	2,200	6,490	A.
April	7,100	1,400	3,080	A.
May	7,200	991	2,450	A.
June	10,800	1,920	5,400	A.
July	5,920	679	1,920	A.
August	1,100	455	641	A.
September	1,640	455	718	A.
October	549	425	450	B.
November	645	425	494	B.
December	2,200	517	1,190	A.
The year	11,100	425	2,380	

TALLAHATCHIE RIVER AT PHILIPP, MISS.

This station is located at the Yazoo Mississippi & Valley Railroad bridge at Philipp. It was established September 6, 1908, for the purpose of obtaining run-off data in connection with the work of the Tallahatchie drainage commission.

The stream above the station will at times overflow the surrounding country for a distance of several miles on either side. The overflow, however, with small exceptions, is intercepted by the railroad embankment and is made to flow in the main channel at the gaging station, and a few trestled openings in the railroad embankment. Variations in the relative stage of the river below the station will probably so affect the slope as to disturb the relation between gage heights and discharge. Judging by the plotting of the discharge measurements so far made, this disturbance does not appear to be great.

The datum of the gage, which is a vertical staff, is mean sea level; the gage readings therefore represent elevations above sea level. Measurements are made from the downstream side of the railway bridge.

Discharge measurements of Tallahatchie River at Philipp, Miss., in 1908–9.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1908.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 13	M. R. Hall	192	2,680	124.38	6,670
December 5	W. A. Lamb	142	1,080	115.35	1,880
1909.					
January 29	Engineers of Tallahatchie drainage commission	178	1,300	115.70	1,760
March 3	W. A. Lamb	254	4,470	132.65	11,800
March 11	Engineers of Tallahatchie drainage commission	306	6,480	135.83	[a]12,500
March 19	do			136.20	[b]20,300
March 26	do			136.85	[c]20,900
May 1	do	210	4,740	129.70	8,710
May 22	do	204	2,850	122.60	5,560
June 4	do	300	6,030	133.2	11,800
August 23	E. H. Swett	139	998	113.2	1,180

[a] Does not include overflow.

[b] Including overflow of 7,000 second-feet.

[c] Including overflow of 7,640 second-feet.

Daily gage height, in feet, of Tallahatchie River at Philipp, Miss., for 1909—Continued.

[G. R. Young, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	116.5	115.0	131.9	136.4	129.9	131.3	131.7	113.7	112.2	115.1	111.8	113.4
2	116.0	114.9	132.2	136.2	129.5	132.0	131.2	113.6	112.1	114.6	111.8	113.2
3	115.9	114.9	132.6	133.9	129.3	132.5	130.5	113.7	112.1	113.9	111.8	113.0
4	115.5	115.0	132.8	135.0	129.1	133.0	129.5	113.9	112.0	113.2	111.8	112.8
5	115.3	115.2	133.1	134.1	129.1	133.3	128.5	113.8	112.0	112.9	111.8	112.6
6	115.1	115.4	133.4	133.5	129.1	133.5	127.1	113.6	111.9	112.5	111.8	112.5
7	115.6	115.9	133.6	132.8	129.1	133.7	125.9	113.5	112.0	112.3	111.8	112.6
8	115.9	116.1	134.0	132.0	129.1	133.9	124.2	113.8	113.0	112.0	111.8	113.9
9	116.0	116.8	134.3	131.8	129.0	134.0	122.6	114.4	113.4	111.9	111.8	114.5
10	116.1	117.6	134.6	130.6	128.9	134.0	121.0	115.3	113.5	111.9	111.8	115.2
11	116.3	119.0	134.8	129.3	128.6	134.1	120.7	115.5	113.6	111.8	111.8	115.5
12	116.3	120.0	135.0	128.0	128.3	134.2	119.4	115.6	113.8	111.8	111.8	116.9
13	116.3	120.6	135.4	127.4	127.7	134.3	118.5	115.7	114.0	111.8	111.8	117.2
14	115.9	121.0	135.6	127.0	126.8	134.3	118.4	116.0	114.2	111.8	111.8	119.9
15	115.9	122.4	135.8	127.5	125.7	134.3	118.2	116.0	113.9	111.8	111.8	121.0
16	116.3	123.7	135.9	127.7	124.5	134.3	117.8	115.8	113.5	111.8	111.8	121.2
17	116.5	125.0	136.0	128.0	123.3	134.3	117.6	115.3	113.3	111.8	111.8	121.7
18	116.6	126.0	136.1	128.3	122.4	134.3	117.2	114.5	113.0	111.8	112.0	122.0
19	116.7	126.8	136.2	128.5	121.4	134.3	116.8	114.1	112.7	111.8	112.7	122.2
20	117.3	127.4	136.4	128.6	121.4	134.2	116.6	113.9	112.4	111.8	112.9	122.4
21	117.3	128.0	136.5	128.8	122.7	134.1	116.3	113.8	112.5	111.8	113.8	122.6
22	117.7	128.6	136.6	128.9	122.5	134.0	116.2	113.6	113.4	111.9	114.5	122.6
23	117.6	129.1	136.7	129.0	122.8	133.9	116.2	113.3	114.3	111.9	115.0	122.5
24	117.4	129.6	136.8	129.2	123.0	133.8	116.1	113.0	114.7	111.9	115.0	122.4
25	116.9	130.1	136.8	129.4	124.1	133.7	115.0	112.8	115.3	111.8	114.8	122.4

Daily gage height, in feet, of Tallahatchie River at Philipp, Miss., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
26	116.5	130.6	136.8	129.6	125.8	133.6	114.7	112.6	115.3	111.8	114.4	122.7
27	116.0	131.1	136.8	130.0	127.0	133.2	114.5	112.4	115.5	111.8	113.9	123.0
28	115.6	131.6	136.8	130.3	128.3	132.9	114.3	112.2	115.5	111.8	113.6	123.1
29	115.3	....	136.75	130.3	129.0	132.6	114.0	112.2	115.4	111.8	113.5	123.6
30	115.3	....	136.7	130.0	129.5	132.1	113.9	112.2	115.4	111.8	113.5	123.7
31	115.1	....	136.5	....	130.5	....	113.8	112.2	....	111.8	....	123.7

Daily discharge, in second-feet, of Tallahatchie River at Philipp, Miss., for 1908-9.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1908.					1908.				
1	....	1,350	1,030	1,380	16	1,110	1,030	1,130	2,570
2	....	1,320	1,030	1,470	17	1,110	1,030	1,150	2,260
3	....	1,300	1,030	1,560	18	1,090	1,030	1,150	2,060
4	....	1,250	1,030	1,600	19	1,090	1,030	1,130	1,840
5	....	1,220	1,030	1,800	20	1,070	1,030	1,130	1,740
6	1,220	1,170	1,030	1,940	21	1,070	1,030	1,110	1,560
7	1,200	1,150	1,030	2,180	22	1,070	1,030	1,090	1,560
8	1,170	1,150	1,030	2,800	23	1,220	1,030	1,090	1,660
9	1,150	1,130	1,030	3,150	24	1,270	1,030	1,090	1,840
10	1,130	1,110	1,030	3,150	25	1,320	1,030	1,110	1,980
11	1,130	1,070	1,050	3,040	26	1,380	1,030	1,130	1,940
12	1,130	1,050	1,050	3,040	27	1,410	1,030	1,170	1,840
13	1,130	1,050	1,050	3,040	28	1,350	1,030	1,320	2,340
14	1,110	1,050	1,130	2,940	29	1,350	1,030	1,250	2,480
15	1,110	1,050	1,130	2,800	30	1,350	1,030	1,350	2,520
					31	....	1,030	....	2,440

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	2,260	1,700	11.300	20.000	9,940	10,800	11,100	1,300	972	1,740	910	1,220
2	2,060	1,660	11.600	19,500	9,700	11,400	10,700	1,270	956	1,560	910	1.170
3	2,020	1,660	12.000	13,900	9,580	11,900	10,300	1,300	956	1,350	910	1,130
4	1,880	1,700	12,200	16,500	9,460	12.500	9,700	1,350	940	1,170	910	1,090
5	1,800	1,770	12,600	14,300	9,460	12,900	9,100	1,320	940	1,110	910	1,050
6	1,740	1,840	13,000	13,200	9,460	13,200	8,260	1,270	925	1,030	910	1,030
7	1,910	2,020	13,400	12,200	9,460	13,500	7,540	1,250	940	990	910	1,050
8	2,020	2,100	14,100	11,400	9,460	13,900	6,520	1,320	1,130	940	910	1,350
9	2,060	2,390	14,800	11,200	9,400	14,100	5,560	1,500	1,220	925	910	1,530
10	2,100	2,750	15,500	10,400	9,340	14,100	4,600	1,800	1,250	925	910	1,770
11	2,180	3,460	16,000	9,580	9,160	14,300	4,420	1,880	1,270	910	910	1,880
12	2,180	4,000	16,500	8,800	8,980	14,500	3,680	1.910	1,320	910	910	2,440
13	2,180	4,360	17,500	8,440	8,620	14,800	3,200	1,940	1,380	910	910	2,570
14	2,020	4,600	18,000	8,200	8,080	14,800	3,150	2,060	1,440	910	910	3,950
15	2,020	5,440	18,500	8,500	7,420	14,800	3,040	2,060	1,350	910	910	4,600
16	2,180	6,220	18,700	8,620	6,700	14,800	2,840	1,980	1,250	910	910	4.720
17	2,260	7,000	19,000	8,800	5,980	14,800	2,750	1,800	1,200	910	910	5,020
18	2.300	7,600	19,200	8,980	5,440	14,800	2,570	1,530	1,130	910	940	5,200
19	2,340	8,080	19,500	9,100	4,840	14,800	2,390	1,410	1,070	910	1,070	5,320
20	2,620	8,440	20,000	9,160	4,840	14,500	2,300	1,350	1,010	910	1,110	5,440
21	2,620	8.800	20,200	9,280	5,260	14.300	2,180	1,320	1,030	910	1,320	5.560
22	2,800	9,160	20,500	9,340	5,500	14,100	2,140	1,270	1,220	925	1,530	5,560
23	2,750	9,460	20,700	9,400	5,680	13.900	2,140	1,200	1,470	925	1,700	5,500
24	2,660	9,760	21,000	9,520	5,800	13,700	2,100	1,130	1,600	925	1,700	5,440
25	2,440	10,100	21,000	9,640	6,460	13,500	1,700	1,090	1,800	910	1,630	5,440
26	2,260	10,400	21,000	9,760	7,480	13,400	1.600	1.050	1,800	910	1,500	5,620
27	2,060	10,700	21,000	10,000	8,200	12,700	1,530	1,010	1.880	910	1,350	5,800
28	1,910	11,000	21,000	10,200	8,980	12,300	1,470	972	1,880	910	1.270	5,860
29	1,800	....	20,900	10,200	9,400	12,000	1,380	972	1.840	910	1,250	6,160
30	1,800	....	20,700	10,000	9,700	11,500	1,350	972	1,840	910	1,250	6,220
31	1,740	....	20,200	....	10,300	....	1,320	972	....	910	....	6,220

NOTE.—The above daily discharges are based on a rating curve fairly well defined between discharges 1,130 and 9,400 second-feet. For higher discharges the rating curve is only approximate.

Monthly discharge of Tallahatchie River at Philipp, Miss., for 1908-9.

Month.	Discharge in second-feet.			Accuracy.
	Maximum.	Minimum.	Mean.	
1908.				
September 6-30	1,410	1,070	1,190	B.
October	1,350	1,030	1,090	B.
November	1,350	1,030	1,110	B.
December	3,150	1,380	2,210	B.
1909.				
January	2,800	1,740	2,160	B.
February	11,000	1,660	5,650	B.
March	21,000	11,300	17,500	C.
April	20,000	8,200	10,900	C.
May	10,300	4,840	8,010	B.
June	14,800	10,800	13,600	C.
July	11,100	1,320	4,280	B.
August	2,060	972	1,410	B.
September	1.880	925	1,300	B.
October	1,740	910	997	B.
November	1,700	910	1,100	B.
December	6,220	1,030	3,770	B.
The year	21,000	910	5,890	

YAZOO RIVER AT GREENWOOD, MISS.

This station, which is located at the highway bridge at Greenwood, a point about 1 mile below the junction of Yalobusha River, was established July 15, 1908, for the purpose of obtaining general run-off data applicable to navigation and drainage problems, and is maintained in cooperation with the Tallahatchie drainage commission.

There are no artificial diversions of water above the station, and all natural diversions return to river above unless at extreme floods some overflow water may be lost to Sunflower River. The conditions at the station are favorable for accurate discharge measurements at all stages, but it is expected that the relation between gage heights and discharges will be greatly disturbed by changes in slope of Yazoo River, caused by varying stages of Mississippi River.

The chain gage is fastened to the downstream handrail of the bridge. Its datum is mean sea level and has not been changed. Discharge measurements are made from this bridge. The United States Weather Bureau has maintained a gage here since November 1, 1904, the datum of which was 92.5 feet above sea level.

The gage heights from January 1 to July 15, 1908, are from the United States Weather Bureau gage and have been adjusted to conform to the sea-level datum of the new gage.

Discharge measurements of Yazoo River at Greenwood, Miss., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 27	W. A. Lamb	411	7,860	115.60	17,100
March 4	do	416	8,270	116.55	19,000
March 12	Engineers of Tallahatchie drainage commission	660	9,690	118.51	21,900
March 27	do	662	13,300	122.72	28,600
April 3	do	659	11,500	121.65	24,300
August 24	E. H. Swett	260	1,540	94.67	1,690
August 26	do	259	1,430	94.28	1,450
August 27	do	258	1,400	94.16	1,410

Daily gage height, in feet, of Yazoo River at Greenwood, Miss., for 1909.

[W. T. Davis, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	97.56	95.36	115.86	122.18	116.25	120.34	115.59	95.50	93.72	96.19	93.31	94.52
2	97.20	95.26	115.62	121.94	116.28	121.01	115.07	95.75	93.69	95.89	93.28	94.50
3	96.82	95.18	116.28	121.58	115.76	121.42	114.47	95.82	93.67	95.55	93.27	94.41
4	96.48	95.10	116.55	121.17	115.56	121.67	113.76	95.72	93.63	95.11	93.26	94.28
5	96.22	95.19	116.80	120.70	115.36	121.86	113.28	95.64	93.59	94.68	93.26	94.22
6	96.02	95.65	117.35	120.20	115.20	121.98	111.98	95.48	93.55	94.35	93.26	94.08
7	95.88	96.70	117.33	119.73	115.05	122.11	110.94	95.34	93.52	94.08	93.26	94.41
8	96.02	97.29	117.60	119.26	114.85	122.14	109.75	95.40	93.52	93.87	93.26	94.68
9	96.25	97.56	117.96	118.53	114.56	122.09	108.51	95.54	94.03	93.72	93.24	95.14
10	96.32	99.60	118.25	117.68	114.33	122.25	107.20	95.99	94.44	93.61	93.22	95.78
11	96.30	102.30	118.41	116.72	113.55	121.89	106.16	96.58	94.44	93.52	93.22	96.19
12	96.30	103.36	118.52	115.63	112.75	121.75	104.39	96.68	94.62	93.46	93.20	96.53
13	96.32	103.47	119.06	115.42	111.82	121.60	102.98	96.56	94.88	93.41	93.19	97.11
14	96.32	103.80	119.81	115.54	110.80	121.42	101.88	96.52	95.10	93.35	93.18	98.48
15	96.30	106.72	120.30	115.21	109.78	121.19	100.92	96.68	95.12	93.31	93.19	99.90
16	96.28	108.79	120.12	114.90	108.68	120.89	100.08	96.78	95.07	93.30	93.26	100.71
17	96.47	108.90	120.20	114.62	107.64	120.55	99.45	96.63	94.92	93.27	93.42	101.14
18	96.65	109.25	120.28	114.50	107.52	120.29	99.18	96.25	94.69	93.25	93.48	101.42
19	96.75	109.95	120.45	114.35	107.10	120.28	98.44	95.82	94.35	93.22	93.50	101.69
20	96.91	110.85	121.44	114.23	106.78	119.70	97.85	95.53	94.13	93.24	93.58	101.87
21	97.09	111.45	122.09	114.26	106.76	119.34	97.33	95.30	94.37	93.49	93.94	101.96
22	97.33	111.81	122.38	113.92	106.82	119.03	97.05	95.07	95.34	93.38	94.53	101.98
23	97.50	112.67	122.51	114.00	106.97	118.92	96.76	94.82	95.57	93.34	95.04	101.98
24	97.54	114.0	122.59	114.50	107.55	118.67	96.68	94.57	96.86	93.30	95.37	102.08
25	97.52	115.12	122.64	114.32	110.26	118.22	96.57	94.41	96.90	93.30	95.52	102.51
26	97.27	115.43	122.68	115.95	113.80	117.83	96.34	94.23	96.79	93.30	95.45	103.30
27	96.98	115.62	122.72	116.76	116.33	117.45	96.38	94.10	96.57	93.30	95.30	103.73
28	96.59	115.65	122.72	117.30	117.27	116.99	95.90	93.97	96.36	93.30	95.01	103.82
29	96.27	....	122.66	116.92	117.65	116.54	95.72	93.88	96.29	93.30	94.72	103.85
30	95.88	....	122.56	116.58	118.03	116.07	95.58	93.80	96.25	93.32	94.56	103.89
31	95.55	....	122.38	....	119.18	....	95.50	93.73	....	93.35	....	103.87

COLDWATER RIVER AT SAVAGE, MISS.

This station is located at the Yazoo & Mississippi Valley Railroad bridge at Savage, about 5 miles below the place where the river leaves the hills and enters the delta. It was established July 1, 1908, for the purpose of determining the amount of water entering the delta from the foothills and is maintained in cooperation with the Tallahatchie drainage commission.

Although there are large overflow areas along the banks of the river, the flow is practically confined by the railroad embankments to the channel under the bridge and can be conveniently measured at all stages.

The gage, which consists of two vertical sections just below the bridge, is set on sea level datum so as to read actual elevations. Measurements are made from the downstream side of the bridge.

Discharge measurements of Coldwater River at Savage, Miss., in 1908–9.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1908.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 11	M. R. Hall	255	3,490	182.99	5,190
December 2	W. A. Lamb	136	1,440	173.00	1,060
1909.					
January 20	Engineers of the Tallahatchie drainage commission	114	946	170.36	449
February 6	do	180	1,630	174.35	1,310
February 9	do	197	2,170	176.87	1,910
February 15	do	253	2,740	179.81	2,230
February 18	do			185.85	[a] 10,800
February 27	do	260	3,570	183.98	5,140
March 1	W. A. Lamb	281	3,700	183.78	5,820
March 13	Engineers of the Tallahatchie drainage commission	265	3,360	182.70	4,920
March 18	do	265	3,280	182.53	4,360
March 22	do	213	2,120	177.10	1,540
March 24	do	159	1,410	172.65	771
March 27	do	128	936	169.24	399
April 17	do	246	2,610	180.51	3,310
April 21	do	250	2,830	180.08	2,980
June 3	do			186.00	[b] 11,200

[a] Includes overflow of 2,640 second-feet.

[b] Includes overflow of 2,950 second-feet.

Daily gage height, in feet, of Coldwater River at Savage, Miss., for 1909.

[O. F. Brock, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	168.0	170.9	183.8	167.9	173.2	185.45	170.5	166.1	165.8	166.3	166.0	166.9
2	168.2	170.0	183.6	167.6	175.85	185.8	170.8	166.0	165.8	166.1	166.0	166.8
3	167.9	169.8	183.5	167.5	176.3	186.1	170.8	166.0	165.8	166.1	166.0	167.0
4	167.6	168.7	182.95	167.4	177.2	185.85	170.9	166.0	165.8	166.0	166.0	167.0
5	167.5	167.15	182.5	167.2	176.2	185.5	170.4	166.0	166.0	166.0	166.0	167.9
6	169.0	173.5	181.8	167.2	174.9	184.8	170.1	166.0	166.3	165.9	166.0	168.0
7	171.3	175.2	181.2	168.75	172.0	184.2	169.5	166.85	169.2	165.9	166.0	170.5
8	172.7	176.1	180.65	172.5	170.4	183.5	168.5	172.2	170.2	165.9	166.0	173.5
9	172.0	176.85	180.5	174.5	169.4	182.55	168.2	173.8	173.1	165.9	166.2	174.3
10	170.6	177.6	180.8	175.6	172.1	180.85	167.5	174.4	172.2	165.9	166.3	175.5
11	168.8	177.9	181.4	175.0	172.2	178.5	168.4	173.85	171.1	165.9	166.3	175.8
12	167.7	177.85	182.15	173.5	172.8	178.0	168.8	175.5	166.2	165.9	166.3	180.2
13	167.2	177.35	182.6	175.2	172.5	177.6	167.85	168.9	166.1	165.9	166.1	180.7
14	167.1	177.85	182.8	178.4	171.1	177.1	166.85	168.1	166.0	165.9	166.1	181.5
15	167.2	179.65	183.05	179.3	169.4	176.85	167.0	170.1	165.9	165.9	166.9	184.3
16	167.8	....	183.0	180.05	168.5	176.9	166.7	170.7	165.9	165.9	173.1	185.0
17	170.0	184.1	182.85	180.45	167.7	176.9	166.8	169.0	165.9	165.9	174.9	183.2
18	170.9	185.75	182.55	181.0	167.2	176.6	166.8	168.5	165.8	165.9	175.5	183.2
19	171.75	186.0	182.0	181.4	167.7	175.0	167.2	166.9	165.7	165.9	174.7	183.2
20	170.9	185.85	181.0	181.2	170.8	173.0	167.2	166.8	165.7	166.0	173.4	183.2
21	169.7	185.45	179.4	180.3	172.2	171.0	167.0	166.2	166.0	166.4	169.4	180.7
22	168.1	185.2	177.2	178.0	174.0	169.3	166.7	166.2	169.0	166.3	169.0	178.8
23	167.5	184.8	174.5	174.2	175.0	169.5	166.4	166.1	170.1	166.3	168.5	176.0
24	167.2	184.6	172.7	172.4	176.1	168.8	166.1	165.1	170.8	166.0	169.5	173.0
25	166.9	184.3	171.2	170.5	177.2	171.3	166.1	165.9	170.9	166.0	170.5	176.0
26	166.9	183.95	170.0	172.2	178.0	172.5	166.1	165.9	170.8	166.0	170.4	178.0
27	166.9	183.95	169.2	172.8	179.0	172.5	166.1	165.9	167.9	166.0	169.2	178.5
28	166.8	183.9	169.0	173.2	180.0	172.5	166.2	165.9	167.4	165.9	168.3	178.6
29	167.2	....	168.75	173.6	181.75	169.4	166.1	165.8	166.5	165.9	167.5	178.5
30	168.25	....	168.5	172.0	184.0	168.8	166.0	165.8	166.3	165.9	167.0	178.4
31	169.9	....	168.2	....	184.9	....	166.0	165.8	....	165.9	....	177.4

Daily discharge, in second-feet, of Coldwater River at Savage, Miss., for 1908-9.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1908				1908.				1908.			
1	181	118	837	11	112	144	779	21	115	130	181
2	148	118	890	12	112	151	559	22	115	130	205
3	127	121	787	13	112	158	362	23	115	137	245
4	121	124	548	14	112	173	272	24	115	148	471
5	118	124	410	15	112	173	245	25	115	158	683
6	118	124	290	16	112	165	205	26	112	177	644
7	115	124	803	17	112	162	197	27	112	355	471
8	115	124	1,020	18	115	148	181	28	112	430	326
9	115	137	1,030	19	115	137	181	29	118	740	281
10	112	144	993	20	115	130	165	30	118	779	272
								31	118	......	281

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	290	583	6,970	281	926	10,100	537	137	118	151	130	197
2	308	482	6,590	254	1,520	10,800	571	130	118	137	130	189
3	281	460	6,400	245	1,650	11,300	571	130	118	137	130	205
4	254	353	5,360	237	1,910	10,900	583	130	118	130	130	205
5	245	217	4,660	221	1,620	10,200	526	130	130	130	130	281
6	380	983	4,020	221	1,296	8,870	493	130	151	124	130	290
7	631	1,360	3,620	358	720	7,730	430	193	400	124	130	537
8	837	1,590	3,320	803	525	6,400	335	755	504	124	130	983
9	725	1,800	3,240	1,190	420	4,730	308	1,040	908	124	144	1,150
10	548	2,040	3,390	1,460	740	3,420	245	1,170	755	124	151	1,430
11	362	2,140	3,740	1,310	755	2,360	326	1,050	607	124	151	1,510
12	263	2,130	4,300	983	854	2,180	362	1,430	144	124	151	3,090
13	221	1,960	4,800	1,360	803	2,040	276	371	137	124	137	3,340
14	213	2,130	5,100	2,320	607	1,880	193	299	130	124	137	3,800
15	221	2,840	5,540	2,680	420	1,880	205	493	124	124	197	7,920
16	272	5,190	5,450	3,020	335	1,820	181	559	124	124	908	9,250
17	482	7,540	5,180	3,220	263	1,820	189	380	124	124	1,290	5,830
18	583	10,700	4,730	3,500	221	1,730	189	335	118	124	1,430	5,830
19	690	11,200	4,180	3,740	263	1,310	221	197	112	124	1,240	5,830
20	583	10,900	3,500	3,620	571	890	221	189	112	130	964	5,830
21	450	10,100	2,730	3,140	755	595	205	144	130	158	420	3,340
22	299	9,630	1,910	2,180	1,080	410	181	144	380	151	380	2,480
23	245	8,870	1,190	1,130	1,310	430	158	137	493	151	335	1,560
24	221	8,490	837	787	1,590	362	137	76	571	130	430	890
25	197	7,920	619	537	1,910	631	137	124	583	130	537	1,560
26	197	7,260	482	755	2,180	803	137	124	571	130	526	2,180
27	197	7,260	400	854	2,560	803	137	124	281	130	400	2,360
28	189	7,160	380	926	3,000	803	144	124	237	124	317	2,400
29	221	....	358	1,000	3,980	420	137	118	165	124	245	2,360
30	312	....	335	725	7,350	392	130	118	151	124	205	2,320
31	471	....	308	....	9,060	....	130	118	....	124	....	1,980

NOTE.—The above daily discharges are based on a rating curve fairly well defined between discharges 380 and 5,450 second-feet.

Monthly discharge of Coldwater River at Savage, Miss., for 1908-9.

Month.	Discharge in second-feet.			Accuracy.
	Maximum.	Minimum.	Mean.	
1908.				
October	181	112	118	B.
November	779	118	199	B.
December	1,030	165	478	B.
1909.				
January	837	189	367	A.
February	11,200	217	4,760	B.
March	6,970	308	3,340	B.
April	3,740	221	1,440	A.
May	9,060	221	1,650	A.
June	11,300	362	3,600	A.
July	583	130	277	B.
August	1,430	76	342	B.
September	908	112	287	B.
October	158	124	130	B.
November	1,430	130	391	B.
December	9,250	189	2,620	A.
The year	11,300	76	1,600	

YALOBUSHA RIVER AT GRENADA, MISS.

This station, which was established June 14, 1906, for the purpose of obtaining general run-off data, is located in the western part of Grenada at the county highway bridge, about one-half mile from the depot and the same distance below the crossing of the Illinois Central Railroad. It is below the mouth of Bataupan Bogue, which comes in a short distance above the railroad bridge. The gage chain was stolen a second time on November 2, 1906, and the station was temporarily abandoned. On July 7, 1908, the station was again established in connection with the Tallahatchie drainage commission, using the same gage datum as formerly. The gage is located on the bridge.

The left bank is not liable to overflow. The ground on the right bank is low for a long distance, but is crossed by the public highway embankment, which is above high water except at a few bridged openings.

Conditions are favorable for accurate discharge measurements which are made from the bridge. It is probable that the station rating will be somewhat affected by backwater from Yazoo River and also by shifting of the stream bed.

Discharge measurements of Yalobusha River at Grenada, Miss., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 20	W. R. Wallis		2,360	16.46	6,840
February 26	W. A. Lamb	185	2,930	21.52	[a] 8,590
June 3	W. R. Wallis			24.17	[b] 15,200
August 28	E. H. Swett	58	62	1.15	60

[a] Overflow not measured.

[b] Includes an overflow of 3,010 second-feet.

Daily gage height, in feet, of Yalobusha River at Grenada, Miss., for 1909.

[W. C. Carroll, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	1.75	21.5	3.8	17.4	24.2	2.65	2.15	1.1	1.3	0.95	1.1
2	2.2	1.7	20.5	3.8	16.4	24.4	2.6	1.75	1.0	1.05	1.0	1.2
3	2.2	1.65	20.0	3.7	16.0	24.2	2.35	2.25	1.0	1.3	1.0	1.65
4	2.25	1.5	19.2	3.4	15.0	23.2	2.6	1.8	.95	1.2	1.1	2.0
5	2.3	1.55	15.0	3.2	14.2	21.2	2.55	1.65	.95	1.15	.95	1.7
6	2.25	1.9	12.2	3.2	13.0	20.8	2.8	1.8	.95	1.15	1.0	1.65
7	2.2	2.7	11.0	5.4	8.4	20.4	2.35	1.55	.95	1.1	1.1	1.4
8	2.2	3.3	10.4	5.6	6.0	19.1	2.05	3.0	.9	1.1	1.1	1.3
9	2.15	8.0	9.2	5.6	5.8	17.6	1.85	3.6	.95	1.1	1.05	1.85
10	2.15	12.5	10.4	5.8	5.6	14.0	1.75	3.0	1.05	1.05	1.1	2.0
11	2.15	11.8	12.0	5.2	4.7	9.6	1.7	2.35	1.15	1.0	1.05	2.1
12	2.15	11.5	14.9	4.5	4.0	6.0	1.65	1.55	1.7	1.0	1.1	2.45
13	2.2	10.0	20.0	12.4	3.8	7.0	1.6	1.5	1.6	.95	1.1	2.3
14	2.2	10.5	20.5	17.0	3.4	10.4	2.05	1.35	1.5	1.05	1.1	2.85
15	2.2	18.4	21.4	15.0	3.2	8.0	2.55	1.65	1.35	1.06	1.05	3.0
16	2.25	18.1	22.0	14.4	3.0	7.0	3.2	1.6	1.35	1.0	1.05	3.4
17	2.3	17.0	22.4	13.8	2.9	6.2	2.85	1.55	1.25	1.0	1.1	3.2
18	2.45	16.9	22.2	13.6	4.1	5.8	2.35	1.45	.95	.95	1.1	2.9
19	2.6	16.8	21.4	13.6	7.2	4.0	2.05	1.45	.9	.95	1.0	2.65
20	2.5	16.6	22.0	13.4	8.0	4.0	1.8	1.4	.9	1.0	.9	2.6
21	2.5	15.4	22.6	11.0	10.4	3.8	1.65	1.35	7.3	1.05	1.0	2.1
22	2.4	15.4	21.5	8.0	11.2	3.8	1.5	1.25	4.2	1.05	1.3	2.5
23	2.35	17.0	20.4	7.4	11.1	3.6	1.55	1.25	3.8	1.0	1.35	2.55
24	2.35	22.3	19.1	7.8	10.8	3.0	2.05	1.2	3.2	1.0	1.45	2.6
25	2.1	22.0	18.2	9.4	21.2	4.0	1.45	1.2	2.85	1.0	1.45	3.0
26	2.05	21.6	17.1	17.4	23.8	4.4	1.4	1.15	2.45	1.1	1.45	2.85
27	2.05	21.0	16.6	18.0	24.6	4.2	1.35	1.15	2.25	1.15	1.4	2.7
28	1.95	22.8	14.1	19.8	23.0	4.2	1.35	1.15	2.1	1.1	1.4	3.1
29	1.95	....	13.3	18.0	22.9	3.9	1.4	1.15	1.95	1.1	1.3	3.4
30	1.9	....	9.1	17.6	23.0	2.8	1.4	1.15	1.7	1.1	1.2	3.2
31	1.95	....	5.3	....	23.9	....	1.4	1.15	....	.95	....	2.9

Daily discharge, in second-feet, of Yalobusha River at Grenada, Miss., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	302	160	11,500	690	7,600	15,300	378	252	55	80	40	55
2	265	150	10,300	690	6,980	15,600	365	160	45	50	45	65
3	265	140	9,750	660	6,750	15,300	302	278	45	80	45	140
4	278	110	8,980	570	6,200	13,800	365	170	40	65	55	215
5	290	120	6,200	515	5,760	11,100	352	140	40	60	40	150
6	278	190	4,660	515	5,100	10,600	415	170	40	60	45	140
7	265	390	4,000	1,240	2,570	10,200	302	120	40	55	55	95
8	265	540	3,670	1,310	1,470	8,890	228	465	35	55	55	80
9	232	2,350	3,010	1,310	1,390	7,720	180	630	40	55	50	180
10	232	4,820	3,670	1,390	1,310	5,650	160	465	50	50	55	215
11	232	4,440	4,550	1,160	990	3,230	150	302	60	45	50	240
12	232	4,280	6,140	920	750	1,470	140	120	150	45	55	328
13	265	3,450	9,750	4,770	690	1,880	130	110	130	40	55	290
14	265	3,720	10,300	7,340	570	3,670	228	88	110	50	55	428
15	265	8,300	11,400	6,200	515	2,350	352	140	88	50	50	465
16	278	8,080	12,100	5,870	465	1,880	515	130	88	45	50	570
17	290	7,340	12,700	5,540	440	1,550	428	120	72	45	55	515
18	328	7,280	12,400	5,430	780	1,390	302	102	40	40	55	440
19	365	7,220	11,400	5,430	1,970	750	228	102	35	40	45	378
20	340	7,110	12,100	5,320	2,350	750	170	95	35	45	35	365
21	340	6,420	13,000	4,000	3,670	690	140	88	2,020	50	45	240
22	315	6,420	11,500	2,350	4,110	690	110	72	815	50	80	340
23	302	7,340	10,200	2,060	4,060	630	120	72	690	45	88	352
24	302	12,500	8,890	2,250	3,890	465	228	65	515	45	102	365
25	240	12,100	8,150	3,120	11,100	750	102	65	428	45	102	465
26	228	11,600	7,400	7,600	14,700	885	95	60	328	55	102	428
27	228	10,900	7,100	8,000	15,900	815	88	60	278	60	95	390
28	202	13,200	5,700	9,550	13,500	815	88	60	240	55	95	490
29	202	....	5,260	8,000	13,400	720	95	60	202	55	80	570
30	190	....	2,960	7,720	13,500	415	95	60	150	55	65	515
31	202	....	1,200	....	14,800	....	95	60	....	40	....	440

NOTE.—The above daily discharges are based on a rating curve which is fairly well defined.

Monthly discharge of Yalobusha River at Grenada, Miss., for 1909.

Month.	Discharge in second-feet.			Accuracy.
	Maximum.	Minimum.	Mean.	
January	365	190	267	C.
February	13,200	110	5,380	B.
March	13,000	1,200	8,030	B.
April	9,550	515	3,720	B.
May	15,900	440	5,400	B.
June	15,600	415	4,670	B.
July	515	88	224	C.
August	630	60	157	C.
September	2,020	35	230	C.
October	80	40	51.9	C.
November	102	35	61.5	C.
December	570	55	321	C.
The year	15,900	35	2,380	

SUNFLOWER RIVER NEAR RULEVILLE, MISS.

This station, which was established June 15, 1908, and is maintained in cooperation with the Tallahatchie drainage commission, is located at the new iron wagon bridge 3 miles southwest of Ruleville, Miss. The gage was not installed until early in October, 1908, and readings were then intermittent until the end of 1908.

The drainage area above the station is very flat and is cut by a number of small tributaries and bayous. The river at the station and below has a very small amount of slope, making the current too sluggish for measurements at times. The amount of slope and consequently of velocity varies greatly with the stage of Mississippi River, making it impossible to rate the station in the usual way by basing daily discharges upon the daily gage heights.

As the gage, which consists of two vertical sections below the bridge, is set to sea-level datum, the gage readings are actual elevations above the sea. Measurements are made from the downstream side of the bridge.

Discharge measurements of Sunflower River near Ruleville, Miss., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet.*	*Sec.-ft.*
February 21	W. A. Lamb	229	3,640	106.53	2,380
February 22	do	229	3,660	106.65	2,280
August 25	E. H. Swett	196	1,680	97.70	175

Daily gage height, in feet, of Sunflower River near Ruleville, Miss., for 1909.

[W. E. McMathe, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	98.0	97.9	103.4	99.4	104.3	112.75	99.32	98.0	97.8	97.75	97.7	97.7
2	98.0	97.85	102.75	99.5	103.9	113.25	99.3	97.95	97.8	97.7	97.7	97.7
3	98.0	97.75	102.0	99.3	103.15	112.98	99.25	97.9	97.8	97.7	97.7	97.7
4	98.0	97.65	101.25	99.3	102.5	112.22	99.08	97.85	97.8	97.7	97.7	97.7
5	98.0	97.65	100.8	99.3	101.95	110.8	98.88	97.82	97.8	97.7	97.7	97.7
6	98.0	97.7	100.35	99.3	101.95	109.6	98.78	97.8	97.8	97.7	97.7	97.7
7	98.0	97.9	100.05	99.3	101.95	108.25	98.68	97.8	97.8	97.7	97.7	97.7
8	98.0	97.95	99.85	99.3	101.88	107.0	98.58	97.8	97.8	97.7	97.7	97.7
9	98.0	98.1	99.8	99.3	101.5	105.4	98.48	97.8	97.8	97.7	97.7	97.7
10	98.0	98.25	101.1	99.3	101.02	104.3	98.38	97.8	97.8	97.7	97.7	97.7
11	98.0	98.3	101.95	99.3	100.5	103.25	98.28	97.8	97.8	97.7	97.7	97.8
12	98.0	98.4	102.15	99.3	100.15	102.75	98.2	97.8	97.78	97.7	97.7	98.65
13	98.0	98.5	103.35	99.82	99.4	103.45	98.2	97.8	97.75	97.7	97.7	99.55
14	98.1	99.3	106.05	101.6	99.65	104.65	98.2	97.8	97.72	97.7	97.7	100.15
15	98.1	101.0	108.1	102.25	99.42	105.5	98.2	97.8	97.7	97.7	97.7	100.32
16	98.1	104.45	108.7	102.35	99.4	105.55	98.2	97.8	97.68	97.7	97.7	100.32
17	98.1	105.9	106.9	101.9	99.5	104.65	98.2	97.8	97.65	97.7	97.7	100.28
18	98.1	105.6	105.9	101.28	99.75	104.15	98.12	97.8	97.6	97.7	97.7	100.2
19	98.0	106.45	104.35	100.92	100.05	103.8	98.0	97.8	97.6	97.7	97.7	100.2
20	98.0	106.5	104.5	100.3	100.3	102.55	98.0	97.8	97.6	97.7	97.7	100.2
21	98.0	106.65	105.2	99.72	100.65	101.8	98.0	97.8	97.62	97.7	97.7	100.32
22	98.0	106.8	105.4	99.5	100.75	101.45	98.0	97.8	97.72	97.7	97.7	100.55
23	98.0	106.65	105.15	99.4	100.6	101.3	98.0	97.8	97.78	97.7	97.7	100.9
24	98.0	106.4	104.3	99.3	100.4	101.3	98.0	97.8	97.85	97.7	97.7	100.75
25	98.0	105.55	103.55	100.48	103.05	101.3	98.0	97.8	97.85	97.7	97.7	100.5
26	98.0	105.7	102.8	102.28	106.8	100.65	98.0	97.8	97.85	97.7	97.7	101.95
27	98.0	104.7	102.1	102.98	110.95	100.75	98.0	97.8	97.85	97.7	97.7	102.55
28	98.0	104.9	101.45	104.22	111.75	100.35	98.0	97.8	97.85	97.7	97.7	102.75
29	98.0	....	101.75	104.5	111.35	99.9	98.0	97.8	97.8	97.7	97.7	102.8
30	98.0	....	101.55	104.05	110.42	99.52	98.0	97.8	97.78	97.7	97.7	102.25
31	98.0	....	100.75	....	111.28	....	98.0	....	....	97.7	....	101.25

SUNFLOWER RIVER AT BAIRD, MISS.

This station, which is located at the Southern Railway bridge one-half mile west of Baird, Miss., was established June 16, 1908, but the gage was not put in until October 4, 1908. It is maintained in cooperation with the Tallahatchie drainage commission.

Owing to the great variation in height of the outlet of Sunflower River into the Mississippi through the lower portion of Yazoo River and consequently in the slope of Sunflower River, there is no relation whatever between gage heights and discharge at this station.

As the gage, which consists of two vertical sections above the bridge, is set on sea level datum, the readings are elevations above sea level. Measurements are from the downstream side of the bridge.

The United States Army Engineers have maintained a gage at this station for a portion of the time, and the gage heights prior to October 4, 1908, are from their records corrected to the sea level datum of the new gage.

Discharge measurements of Sunflower River at Baird, Miss., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 23	W. A. Lamb	234	3,100	94.25	4,120
August 26	E. H. Swett	172	697	82.90	416

Daily gage height, in feet, of Sunflower River at Baird, Miss., for 1909.

[C. H. Cooper, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	83.5	83.0	94.5	96.5	98.0	103.9	92.0	87.2	......	......	82.7	82.8
2	83.5	83.0	93.9	96.5	97.5	104.3	91.8	87.3	......	......	82.7	82.8
3	83.4	82.9	93.4	96.5	96.9	104.4	91.5	87.3	......	......	82.7	82.8
4	83.3	82 9	92.6	96.5	96.4	104.1	91.3	87.0	......	......	82.7	82.8
5	83.3	82.9	91.8	96.5	95.8	103.8	91.0	86.8	......	......	82.7	82.8
6	83.2	83.1	91.5	96.5	95.3	103.0	90.7	86.4	......	......	82.7	82.9
7	83.1	83.1	90 9	96.4	94.8	102.3	90.3	85.7	......	......	82.7	83.0
8	83.1	83.1	90.5	96.0	94.3	101.5	89.8	85.0	......	......	82.7	83.0
9	83.1	83.3	90.5	95.8	93.8	100.2	89.5	84.4	......	......	82.7	83.0
10	83.0	83.5	90.8	95.6	93.0	99.0	89.2	84.2	......	82.7	82.7	83.0
11	83.0	83.6	91.3	95.4	92.8	98.5	88.6	83.6	......	82.7	82.7	83.0
12	83.0	83.6	91.7	95.2	92.3	98.0	88.0	83.4	......	82.75	82.65	83.2
13	83.0	83.7	93.0	95.8	91.9	97.3	87.5	83.3	......	82.7	82.65	83.3
14	83.0	83.9	94.8	96.0	91.5	96.9	87.0	83.2	......	82.7	82.8	83.4
15	83.0	87.0	96.5	96.0	91.2	97.0	86.5	......	......	82.7	82.8	84.1
16	83.0	89.4	97.4	95.9	91.0	97.0	86.1	......	......	82.7	82.8	84.5
17	83.1	91.3	97.5	95.6	90.8	96.7	85.6	......	......	82.7	82.8	84.7
18	83.1	92.3	97.5	95.2	90.8	96.5	85.2	......	......	82.7	82.8	84.7
19	83.2	93.0	97.7	94.7	91.0	96.0	85.0	......	......	82.7	82.8	84.5
20	83.2	93.5	97.7	94.3	91.8	95.6	84.5	......	......	82.7	82.8	84.3
21	83.2	93.9	98.5	93.9	92.4	95.2	84.3	......	......	82.75	82.8	84.1
22	83.2	94.0	98.7	93.4	92.6	94.6	84.2	......	......	82.75	82.8	84.1
23	83.2	94.3	98.8	93.0	92.7	94.3	84.0	......	......	82.75	82.8	84.2
24	83.1	95.0	98.4	92.8	92.8	93.9	84.0	......	......	82.7	82.8	84.3
25	83.1	95.5	97.9	92.4	95.5	93.5	85.1	......	......	82.7	82.8	84.4
26	83.1	95.6	97.5	95.2	99.5	93.3	85.5	......	......	82.7	82.75	84.7
27	83.1	95.5	97.1	96.7	101.7	93.0	85.9	......	......	82.7	82.75	85.8
28	83.0	95.0	96.9	97.8	102.6	92.8	86.4	......	......	82.7	82.7	86.7
29	83.0	......	96.8	98.3	103.5	92.5	86.6	......	......	82.7	82.7	87.0
30	83.0	......	96.6	98.3	103.6	92.3	87.0	......	......	82.7	82.7	87.0
31	83.0	......	96.5	......	103.7	......	87.1	......	......	82.7	......	86.7

MISCELLANEOUS MEASUREMENTS IN THE LOWER MISSISSIPPI RIVER DRAINAGE BASIN.

The following miscellaneous discharge measurements were made in the lower Mississippi River drainage basin during 1909:

Miscellaneous measurements in lower Mississippi River Basin.

Arkansas River Basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
June 8	Grape Creek	Arkansas River	At mouth Colo		24.6
May 6	De Wesse-Dye Ditch	Grape Creek	Canon City, Colo	[a] 0.50	18.4
June 28	do	do	do	[a] .30	13.8
May 6	Oil Creek	Arkansas River	Denver & Rio Grande R. R. crossing, Canon City, Colo.		10
Do	Oak Creek	do	Florence, Colo		2

[a] Temporary gage one-half mile below headgate.

Miscellaneous measurements in lower Mississippi River Basin—Continued.

Arkansas River Basin—Continued.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Feb. 14	Fountain Creek	Arkansas River	Colorado Springs, Colo.		[a] 5
Do	Cheyenne Creek	Fountain Creek	do		[a] 1.5
May 19	Cucharas River	Arkansas River	8 miles above LaVeta, Colo.	[b] 1.30	59
Do	do	do	La Veta, Colo	[c] 2.13	31
Do	Veta Creek	Cucharas River	do		[b] .5
September 15	Purgatory River	Arkansas River	Higbee, Colo	2.95	48.2
October 23	Canadian River	do	French, N. Mex		[a] 6.5
January 23	Rayado River	Canadian River	Springer, N. Mex	.40	.12
April 8	do	do	do		[a] .5
May 25	do	do	do	.40	[a] .4
January 23	Farmer's Development Canal.	Rayado River	Miami, N. Mex	.70	3.4
May 25	do	do	do	.72	5.6
October 27	Cebolla Creek	Mora River	La Cueva, N. Mex		[a] 3.0
June 25	do	do	At mouth, N. Mex		[a] 1.0

Yazoo River Basin.

February 15	Tallahatchie River	Yazoo River	Polkville, Miss	148.25	7,430
February 21	do	do	do	153.70	12,600
March 2	do	do	do	156.60	17,600
March 7	do	do	do	156.90	16,300
March 17	do	do	do	156.40	15,700
March 23	do	do	do	156.17	15,200
March 29	do	do	do	153.95	11,800
April 24	do	do	do	150.10	8,680
May 5	do	do	do	150.09	8,680
May 7	do	do	do	150.12	8,180
Do	do	do	do	150.08	8,250
June 11	do	do	do	156.40	16,700
January 26	do	do	Locopolis, Miss	125.90	2,140
March 17	do	do	do	145.80	14,800
March 31	do	do	do	144.70	9,520
May 1	do	do	do	138.86	7,880
May 18	do	do	do	129.85	3,620
June 5	do	do	do	143.19	11,400
March 18	do	do	Swan Lake, Miss	142.39	14,500
February 8	Coldwater River	Tallahatchie River	Pratts Bridge, Miss	195.00	2,010
February 17	do	do	do	198.00	15,300
April 16	do	do	do	196.80	4,890
May 28	do	do	do	197.60	10,700
June 1	do	do	do	197.91	12,100
March 24	do	do	Sarah, Miss	170.83	838
February 27	do	do	Askew, Miss	176.80	2,050
March 22	do	do	do	173.15	1,490
February 21	do	do	Hinchcliffe, Miss	155.36	5,740
March 1	do	do	do	158.60	6,660
March 16	do	do	do	158.19	5,880
March 22	do	do	do	157.80	5,400
March 29	do	do	do	154.79	2,710
April 24	do	do	do	153.11	3,460
June 5	do	do	do	157.30	6,050
February 25	Tillatoba Creek	do	South Fork, Charleston, Miss.	164.50	161
Do	do	do	North Fork, Charleston, Miss.	165.55	36
March 15	do	do	Both forks, Charleston, Miss.	166.10	402
March 20	do	do	do	178.60	2,150
Do	do	do	do	177.30	2,130
February 16	Sunflower River	Yazoo River	Clarksdale, Miss	135.91	4,620

Red River Basin.

April 6	Ouachita River	Red River	Arkadelphia, Ark	[d] 3.8	822

[a] Estimated.
[b] Distance below brass tack in end of log at right abutment, downstream side.
[c] Temporary rod gage on bridge one-half mile below mouth of Veta Creek.
[d] Gage on downstream side of highway bridge.

INDEX.

A. Page.
Abreu's ranch, N. Mex.,
Rayado River at:
See Cimarron, N. Mex.
Accuracy, degree of........................... 26-27
Acknowledgments to those aiding........... 28
Acre-foot, definition of....................... 11
Appropriations, amount of.................... 5
Arkadelphia, Ark.,
Ouachita River at:
discharge.............................. 94
Arkansas River at—
Canon City, Colo.:
description........................... 43-44
discharge.............................. 44
discharge, daily...................... 45
discharge, monthly.................. 46
gage heights.......................... 44-45
Holly, Colo.:
description........................... 49-50
discharge.............................. 50
gage heights.......................... 50
Las Animas, Colo.:
description........................... 48-49
discharge.............................. 49
gage heights.......................... 49
Pueblo, Colo.:
description........................... 46
discharge.............................. 47
discharge, daily...................... 48
discharge, monthly.................. 48
gage heights.......................... 47
Salida, Colo.:
description........................... 42
discharge.............................. 42
discharge, daily...................... 43
discharge, monthly.................. 43
gage heights.......................... 43
Arkansas River drainage basin, description of 39-42
gaging stations in........................ 30-31
stream flow in............................. 42-80
Askew, Miss.,
Coldwater River at:
discharge.............................. 94
Authority for investigations.................. 5

B.
Baird, Miss.,
Sunflower River near:
description........................... 92
discharge.............................. 93
gage heights.......................... 93
Batesville, Miss.,
Tallahatchie River at:
description........................... 81
discharge.............................. 81
discharge, daily...................... 82
discharge, monthly.................. 82
gage heights.......................... 81
Beaver, Ark., Page.
White River at:
description........................... 33-34
discharge.............................. 34
gage heights.......................... 34
Bolster, R. H., work of........................ 29
Branson, Mo.,
White River near:
description........................... 34
discharge.............................. 34
gage heights.......................... 35
Buffalo River near—
Gilbert, Ark.:
description........................... 37
discharge.............................. 37
gage heights.......................... 37

C.
Canadian River at—
French, N. Mex.:
discharge.............................. 94
Logan, N. Mex.:
description........................... 57
discharge.............................. 57
discharge, daily...................... 58-59
discharge, monthly.................. 59
gage heights.......................... 58
Canadian River drainage basin, description.. 56
stream flow in............................. 57-80
Canon City, Colo.,
Arkansas River at:
description........................... 43-44
discharge.............................. 44
discharge, daily...................... 45
discharge, monthly.................. 46
gage heights.......................... 44-45
De Wesse-Dye ditch near:
description........................... 51
discharge.............................. 93
See also Grape Creek.
Grape Creek near:
description........................... 51
discharge.............................. 51
gage heights.......................... 52
Oil Creek at:
discharge.............................. 93
Cebolla Creek at—
La Cueva, N. Mex.:
discharge.............................. 94
mouth of creek, N. Mex.:
discharge.............................. 94
Charleston, Miss.,
Tillatoba Creek at:
discharge.............................. 94
Tillatoba Creek (North Fork) at:
discharge.............................. 94
Tillatoba Creek (South Fork) at:
discharge.............................. 94

- Cheyenne Creek at—
  - Colorado Springs, Colo.: Page.
    - discharge.... 94
- Cimarron, N. Mex.,
  - Rayado River near:
    - description.... 67
    - discharge.... 67
    - discharge, daily.... 68-69
    - discharge, monthly.... 69
    - gage heights.... 68
- Cimarron River at—
  - Springer, N. Mex.:
    - description.... 63-64
    - discharge.... 64
    - discharge, daily.... 65-66
    - discharge, monthly.... 66
    - gage heights.... 64
  - Ute Park, N. Mex.:
    - description.... 60
    - discharge.... 60
    - discharge, daily.... 61-62
    - discharge, monthly.... 63
    - gage heights.... 61
- Clarksdale, Miss.,
  - Sunflower River at:
    - discharge.... 94
- Coldwater River at—
  - Askew, Miss.:
    - discharge.... 94
  - Hinchcliffe, Miss.:
    - discharge.... 94
  - Pratts Bridge, Miss.:
    - discharge.... 94
  - Sarah, Miss.:
    - discharge.... 94
  - Savage, Miss.:
    - description.... 86-87
    - discharge.... 87
    - disharge, daily.... 88
    - discharge, monthly.... 89
    - gage heights.... 87
- Colorado Springs, Colo.,
  - Cheyenne Creek at:
    - discharge.... 94
  - Fountain Creek at:
    - discharge.... 94
- Cooperation, credit for.... 28-29
- Cooperative data, use of.... 28
- Cotter, Ark.,
  - White River near:
    - description.... 36
    - discharge.... 36
    - gage heights.... 36
- Cucharas River at and near—
  - La Veta, Colo.:
    - discharge.... 94
- Current meter, description of.... 17-18
  - use of.... 18-19
  - views of.... 18
- Current-meter stations, views of.... 16
- Curves, discharge, figure showing.... 25

D.

- Data, accuracy of.... 26-27
  - use of.... 27
- Definitions of terms.... 11
- De Wesse-Dye ditch near—
  - Canon City, Colo.: Page.
    - description.... 51
    - discharge.... 93
    - *See also* Grape Creek.
- Discharge, computation of.... 18-26
  - curves for.... 19-20
  - graphic method of obtaining.... 23-26
    - figure showing.... 25
    - list of measurements illustrating.... 24
    - table of gage heights and discharges illustrating.... 24
  - measurement of.... 14-19
- Discharge measurements, nature of.... 13
- Domestic water supply, importance of.... 7
- Drainage, stream flow and.... 7-8
- Drainage basins, list of.... 8

E.

- Equivalents, list of.... 12-13

F.

- Farmer's Development canal (Rayado River) at—
  - Miami, N. Mex.:
    - discharge.... 94
- Field methods, features of.... 14-19
- Float method, description of.... 17
- Floods, prevention of.... 8
- Florence, Colo.,
  - Oak Creek at:
    - discharge.... 93
- Fountain Creek at—
  - Colorado Springs, Colo.:
    - discharge.... 94
- Freeman, W. B., work of.... 29
- French, N. Mex.,
  - Canadian River at:
    - discharge.... 94

G.

- Gage heights, reading of.... 13
- Gaging stations, classes of.... 20-22
  - selection and equipment of.... 17-18
  - views of.... 16
- Gilbert, Ark.,
  - Buffalo River near:
    - description.... 37
    - discharge.... 37
    - gage heights.... 37
- Gladson, W. N., work of.... 29
- Grape Creek at or near—
  - Canon City, Colo.:
    - description.... 51
    - discharge.... 51
    - gage heights.... 52
  - Mouth of creek, Colo.:
    - discharge.... 93
- Greenwood, Miss.,
  - Yazoo River at:
    - description.... 85
    - discharge.... 86
    - gage heights.... 86

- Grenada, Miss.,
  - Yalobusha River at: Page.
    - description.......... 89
    - discharge.......... 89
    - discharge, daily.......... 90
    - discharge, monthly.......... 91
    - gage heights.......... 90

H.

- Hall, M. R., work of.......... 29
- Henderson, Ark.,
  - North Fork River near:
    - description.......... 38
    - discharge.......... 38
    - gage heights.......... 38
- Higbee, Colo.,
  - Purgatory River near:
    - description.......... 54
    - discharge.......... 94
    - gage heights.......... 55
- Hinchcliffe, Miss.,
  - Coldwater River at:
    - discharge.......... 94
- Holly, Colo.,
  - Arkansas River at:
    - description.......... 49-50
    - discharge.......... 50
    - gage heights.......... 50
- Homochitto River basin, gaging station in.......... 31
- Horton, A. H., work of.......... 29

I.

- Ice, measurements under.......... 19, 24-26
- Investigations, authority for.......... 5
  - purposes of.......... 7-8
  - scope of.......... 6
- Irrigation, dependence of, on stream flow.......... 7

K.

- King, L. T., work of.......... 29

L.

- La Cueva, N. Mex.,
  - Cebolla Creek at:
    - discharge.......... 94
  - Mora River near:
    - description.......... 71-72
    - discharge.......... 72
    - discharge, daily.......... 73
    - discharge, monthly.......... 74
    - gage heights.......... 72-73
- La Cueva canal at—
  - La Cueva, N. Mex.:
    - description.......... 71-72
    - discharge.......... 74
    - discharge, daily.......... 75
    - discharge, monthly.......... 75
    - gage heights.......... 74
- Lamb, W. A., work of.......... 29
- Las Animas, Colo.,
  - Arkansas River at:
    - description.......... 48-49
    - discharge.......... 49
    - gage heights.......... 49
  - Purgatory River near:
    - description.......... 55
    - discharge.......... 55
    - gage heights.......... 55
- La Veta, Colo.,
  - Cucharas River at and near: Page.
    - discharge.......... 94
  - Veta Creek at:
    - discharge.......... 94
- Lead Hill, Ark.,
  - White River near:
    - description.......... 35
    - discharge.......... 35
    - gage heights.......... 35
- Little Red River near—
  - Pangburn, Ark.:
    - description.......... 38-39
    - discharge.......... 39
    - gage heights.......... 39
- Locopolis, Miss.,
  - Tallahatchie River at:
    - discharge.......... 94
- Logan, N. Mex.,
  - Canadian River at:
    - description.......... 57
    - discharge.......... 57
    - discharge, daily.......... 58-59
    - discharge, monthly.......... 59
    - gage heights.......... 58
  - Ute Creek near:
    - description.......... 78
    - discharge.......... 78
    - discharge, daily.......... 79
    - discharge, monthly.......... 80
    - gage heights.......... 79
- Los Alamos, N. Mex.,
  - Sapello River at:
    - description.......... 75-76
    - discharge.......... 76
    - discharge, daily.......... 77
    - discharge, monthly.......... 77
    - gage heights.......... 76-77
- Lyon, G. F., work of.......... 29

M.

- McChristie, M. E., work of.......... 29
- Mathers, J. G., work of.......... 29
- Meramec River basin, gaging stations in.......... 29
- Miami, N. Mex.,
  - Farmer's Development canal (Rayado River) at:
    - discharge.......... 94
- Miller, C. D., work of.......... 29
- Miner's inch, definition of.......... 11
- Miscellaneous measurements in—
  - Arkansas River basin.......... 93-94
  - lower Mississippi basin.......... 93-94
  - Red River basin.......... 94
  - Yazoo River basin.......... 94
- Mississippi River basin (lower), gaging stations in.......... 29
  - miscellaneous measurements in.......... 93-94
  - stream flow in.......... 32-94
- Mora River near—
  - La Cueva, N. Mex.:
    - description.......... 71-72
    - discharge.......... 72
    - discharge, daily.......... 73
    - discharge, monthly.......... 74
    - gage heights.......... 72-73

N. Page.

- Navigation, dependence of, on stream flow ... 7
- North Fork River near—
  - Henderson, Ark.:
    - description ... 38
    - discharge ... 38
    - gage heights ... 38

O.

- Oak Creek at—
  - Florence, Colo.:
    - discharge ... 93
- Office methods, features of ... 19-26
- Oil Creek at—
  - Canon City, Colo.:
    - discharge ... 93
- Ouachita River at—
  - Arkadelphia, Ark.:
    - discharge ... 94

P.

- Pangburn, Ark.,
  - Little Red River near:
    - description ... 38-39
    - discharge ... 39
    - gage heights ... 39
- Philipp, Miss.,
  - Tallahatchie River at:
    - description ... 82-83
    - discharge ... 83
    - discharge, daily ... 84
    - discharge, monthly ... 85
    - gage heights ... 83-84
- Polkville, Miss.,
  - Tallahatchie River near:
    - discharge ... 94
- Pratts Bridge, Miss.,
  - Coldwater River at:
    - discharge ... 94
- Price meters, views of ... 18
- Publications, lists of ... 8-11
- Pueblo, Colo.,
  - Arkansas River at:
    - description ... 46
    - discharge ... 47
    - discharge, daily ... 48
    - discharge, monthly ... 48
    - gage heights ... 47
- Purgatory River at or near—
  - Higbee, Colo.:
    - description ... 54
    - discharge ... 94
    - gage heights ... 55
  - Las Animas, Colo.:
    - description ... 55
    - discharge ... 55
    - gage heights ... 55
  - Trinidad, Colo.:
    - description ... 53
    - discharge ... 54
    - gage heights ... 54
- Purgatory River drainage basin, description of ... 52-53
  - stream flow in ... 52-55

R.

- Rating curves, construction and use of ... 20
- Rating tables, construction of ... 20
  - nature of ... 13-14
- Rayado River at or near— Page.
  - Abreu's ranch, N. Mex.:
    - *See* Cimarron, N. Mex.
  - Cimarron, N. Mex.:
    - description ... 67
    - discharge ... 67
    - discharge, daily ... 68-69
    - discharge, monthly ... 69
    - gage heights ... 68
  - Springer, N. Mex.:
    - description ... 69
    - discharge ... 70, 94
    - discharge, daily ... 71
    - discharge, monthly ... 71
    - gage heights ... 70
- Red River basin, gaging stations in ... 31-32
  - miscellaneous measurement in ... 94
- Revision, need for ... 26-27
- Rice, R. C., work of ... 29
- Ruleville, Miss.,
  - Sunflower River near:
    - description ... 91
    - discharge ... 91
    - gage heights ... 92
- Run-off, computation of ... 19-26
  - definition of ... 11
- Russell, G. H., work of ... 29

S.

- Salida, Colo.,
  - Arkansas River at:
    - description ... 42
    - discharge ... 42
    - discharge, daily ... 43
    - discharge, monthly ... 43
    - gage heights ... 43
- Sapello River at—
  - Los Alamos, N. Mex.:
    - description ... 75-76
    - discharge ... 76
    - discharge, daily ... 77
    - discharge, monthly ... 77
    - gage heights ... 76-77
- Sarah, Miss.,
  - Coldwater River at:
    - discharge ... 94
- Savage, Miss.,
  - Coldwater River at:
    - description ... 86-87
    - discharge ... 87
    - discharge, daily ... 88
    - discharge, monthly ... 89
    - gage heights ... 87
- Second-foot, definition of ... 11
- Section, changes in, estimating for ... 21-22
- Slope method, description of ... 14-15
- Springer, N. Mex.,
  - Cimarron River at:
    - description ... 63-64
    - discharge ... 64
    - discharge, daily ... 65-66
    - discharge, monthly ... 66
    - gage heights ... 64
  - Rayado River near:
    - description ... 69
    - discharge ... 70, 94
    - discharge, daily ... 71
    - discharge, monthly ... 71
    - gage heights ... 70

Page.

- Stevens, G. C., work of ... 29
- Stewart, J. B., work of ... 29
- Stream measurement, accuracy of ... 26-27
  - data on, use of ... 27-28
  - methods of ... 14-26
- Sullivan, V. T., work of ... 29
- Sunflower River at or near—
  - Baird, Miss.:
    - description ... 92
    - discharge ... 93
    - gage heights ... 93
  - Clarksdale, Miss.:
    - discharge ... 94
  - Ruleville, Miss.:
    - description ... 91
    - discharge ... 91
    - gage heights ... 92
- Sutton, W. H., work of ... 29
- Swamps, dependence of drainage of, on stream flow ... 7-8
- Swan Lake, Miss.,
  - Tallahatchie River at:
    - discharge ... 94
- Swett, E. H., work of ... 29

T.

- Tables, explanation of ... 13-14
- Tallahatchie River at—
  - Batesville, Miss.:
    - description ... 81
    - discharge ... 81
    - discharge, daily ... 82
    - discharge, monthly ... 82
    - gage heights ... 81
  - Locopolis, Miss.:
    - discharge ... 94
  - Philipp, Miss.:
    - description ... 82-83
    - discharge ... 83
    - discharge, daily ... 84
    - discharge, monthly ... 85
    - gage heights ... 83-84
  - Polkville, Miss.:
    - discharge ... 94
  - Swan Lake, Miss.:
    - discharge ... 94
- Terms, definitions of ... 11
- Tillatoba Creek at—
  - Charleston, Miss.:
    - discharge ... 94
- Tillatoba Creek (North Fork) at—
  - Charleston, Miss.:
    - discharge ... 94
- Tillatoba Creek (South Fork) at—
  - Charleston, Miss.:
    - discharge ... 94
- Trinidad, Colo.,
  - Purgatory River at:
    - description ... 53
    - discharge ... 54
    - gage heights ... 54

U.

- Ute Creek near—
  - Logan, N. Mex.:
    - description ... 78
    - discharge ... 78
    - discharge, daily ... 79
- Ute Creek near—
  - Logan, N. Mex.—Continued.
    - discharge, monthly ... 80
    - gage heights ... 79
- Ute Park, N. Mex.,
  - Cimarron River at:
    - description ... 60
    - discharge ... 60
    - discharge, daily ... 61-62
    - discharge, monthly ... 63
    - gage heights ... 61

V.

- Veta Creek at—
  - La Veta, Colo.:
    - discharge ... 94
- Velocity method, description of ... 15-16

W.

- Walls Ferry, Ark.,
  - White River at:
    - description ... 36-37
    - discharge ... 37
- Walters, M. I., work of ... 29
- Water power, dependence of, on stream flow. 7
- Water supply, dependence of, on stream flow. 7
- Weir method, description of ... 15
- White River at or near—
  - Beaver, Ark.:
    - description ... 33-34
    - discharge ... 34
    - gage heights ... 34
  - Branson, Mo.:
    - description ... 34
    - discharge ... 34
    - gage heights ... 35
  - Cotter, Ark.:
    - description ... 36
    - discharge ... 36
    - gage heights ... 36
  - Lead Hill, Ark.:
    - description ... 35
    - discharge ... 35
    - gage heights ... 35
  - Walls Ferry, Ark.:
    - description ... 36-37
    - discharge ... 37
- White River drainage basin, description of.. 32-33
  - gaging stations in ... 29
  - stream flow in ... 33-39
- Wood, Mrs. B. D., work of ... 29
- Work, division of ... 28-29

Y.

- Yalobusha River at—
  - Grenada, Miss.:
    - description ... 89
    - discharge ... 89
    - discharge, daily ... 90
    - discharge, monthly ... 91
    - gage heights ... 90
- Yazoo River at—
  - Greenwood, Miss.:
    - description ... 85
    - discharge ... 86
    - gage heights ... 86
- Yazoo River drainage basin, description of.. 80
  - gaging stations in ... 31
  - stream flow in ... 81-93

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 268

SURFACE WATER SUPPLY OF THE UNITED STATES

1909

PART VIII. WESTERN GULF OF MEXICO

PREPARED UNDER THE DIRECTION OF M. O. LEIGHTON

BY

W. B. FREEMAN AND R. H. BOLSTER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

CONTENTS.

Page.

Introduction 5

  Authority for investigations 5

  Scope of investigations 6

  Purposes of the work 7

  Publications 8

  Definition of terms 11

  Convenient equivalents 12

  Explanation of tables 13

  Field methods of measuring stream flow 14

  Office methods of computing and studying discharge and run-off 20

  Accuracy and reliability of field data and comparative results 24

  Use of the data 25

  Cooperative data 25

  Cooperation and acknowledgments 26

  Division of work 26

Gaging stations in western Gulf of Mexico drainage basins 27

Rio Grande drainage basin 28

  General features 28

  Rio Grande proper 32

    Rio Grande at Thirtymile Bridge, near Creede, Colo 32

    Rio Grande near Creede, Colo 34

    Rio Grande near Del Norte, Colo 36

    Rio Grande near Lobatos, Colo 38

    Rio Grande near Buckman, N. Mex 41

    Rio Grande near San Marcial, N. Mex 43

    Rio Grande near El Paso, Tex 45

    Rio Grande above Presidio, Tex 48

    Rio Grande below Presidio, Tex 51

    Rio Grande near Langtry, Tex 54

    Rio Grande below Devils River, Tex 56

    Rio Grande at Eagle Pass, Tex 59

    Rio Grande near Laredo, Tex 61

    Rio Grande near Roma, Tex 63

    Rio Grande near Brownsville, Tex 65

  Conejos River basin 67

    Conejos River near Mogote, Colo 67

  Santa Fe Creek basin 69

    Santa Fe Creek at Santa Fe, N. Mex 69

  Flood on Bluewater Creek, N. Mex., Sept. 6, 1909 73

  Mimbres River basin 75

    Mimbres River near Faywood, N. Mex 75

  Cameron Creek basin 78

    Cameron Creek at Fort Bayard, N. Mex 78

    Stephens Creek near Fort Bayard, N. Mex 80

Rio Grande drainage basin—Continued. Page.
Pecos River drainage basin 81
Description 81
Pecos River near Fort Sumner, N. Mex 83
Pecos River near Dayton, N. Mex 86
Pecos River near Lakewood, N. Mex 88
Pecos River near Moorhead, Tex 90
Gallinas River near Las Vegas, N. Mex 93
Devils River drainage basin 95
Devils River at Devils River, Tex 95
Rio Salado drainage basin 97
Rio Salado near Guerrero, Tamaulipas, Mex 97
Rio San Juan drainage basin 99
Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico 99
Miscellaneous measurements in Rio Grande basin 101
Index 103

ILLUSTRATIONS.

Page.
PLATE I. Typical gaging stations; *A*, For bridge measurement; *B*, For wading measurement 16
II. Small Price current meters 18
III. Leasburg diversion dam and headgates of Rio Grande canal looking upstream 30
IV. *A*, The largest concrete drop in main Rio Grande canal; *B*, Concrete flume across Pecos River, N. Mex 30
V. *A*, Rio Grande near Creede, Colo.; *B*, Conejos River near Mogote, Colo 34
VI. *A*, Automatic gage on Mimbres River near Faywood, N. Mex.; *B*, Pecos River valley between Ribera and Fort Sumner, N. Mex.. 76

SURFACE WATER SUPPLY OF THE WESTERN GULF OF MEXICO, 1909.

By W. B. FREEMAN and R. H. BOLSTER.

INTRODUCTION.

AUTHORITY FOR INVESTIGATIONS.

This volume contains results of flow measurements made on certain streams in the United States. The work was performed by the water-resources branch of the United States Geological Survey, either independently or in cooperation with organizations mentioned herein. These investigations are authorized by the organic law of the Geological Survey (Stat. L., vol. 20, p. 394), which provides, among other things, as follows:

> Provided that this officer [the Director] shall have the direction of the Geological Survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

Inasmuch as water is the most abundant and most valuable mineral in nature the investigation of water resources is included under the above provision for investigating mineral resources. The work has been supported since the fiscal year ending June 30, 1895, by appropriations in successive sundry civil bills passed by Congress under the following item:

> For gauging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

The various appropriations that have been made for this purpose are as follows:

Annual appropriations for the fiscal year ending June 30—

1895	$12,500
1896	20,000
1897 to 1900, inclusive	50,000
1901 to 1902, inclusive	100,000
1903 to 1906, inclusive	200,000
1907	150,000
1908 to 1910, inclusive	100,000
1911	150,000

SCOPE OF INVESTIGATIONS.

These investigations are not complete nor do they include all the river systems or parts thereof that might purposefully be studied. The scope of the work is limited by the appropriations available. The field covered is the widest and the character of the work is believed to be the best possible under the controlling conditions. The work would undoubtedly have greater scientific importance and ultimately be of more practical value if the money now expended for wide areas were concentrated on a few small drainage basins; but such a course is impossible because general appropriations made by Congress are applicable to all parts of the country. Each part demands its proportionate share of the benefits.

It is essential that records of stream flow shall be kept during a period of years long enough to determine within reasonable limits the entire range of flow from the absolute maximum to the absolute minimum. The length of such a period manifestly differs for different streams. Experience has shown that the records for some streams should cover from five to ten years, and for other streams twenty years or even more, the limit being determined by the relative importance of the stream and the interdependence of the results with other long-time records on adjacent streams.

In the performance of this work an effort is made to reach the highest degree of precision possible with a rational expenditure of time and a judicious expenditure of a small amount of money. In all engineering work there is a point beyond which refinement is needless and wasteful, and this statement applies with especial force to stream-flow measurements. It is confidently believed that the stream-flow data presented in the publications of the survey are in general sufficiently accurate for all practical purposes. Many of the records are, however, of insufficient length, owing to the unforeseen reduction of appropriations and consequent abandonment of stations. All persons are cautioned to exercise the greatest care in using such incomplete records.

Records have been obtained at more than 1,550 different points in the United States, and in addition the surface water supply of small areas in Seward Peninsula and the Yukon-Tanana region, Alaska, has been investigated. During 1909 regular gaging stations were maintained by the survey and cooperating organizations at about 850 points in the United States, and many miscellaneous measurements were made at other points. Data were also obtained in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country and will be made available in the regular surface water-supply papers and in special papers from time to time.

PURPOSES OF THE WORK.

The results contained in this volume are requisite to meet the immediate demands of many public interests, including navigation, irrigation, domestic water supply, water power, swamp and overflow land drainage, and flood prevention.

Navigation.—The Federal Government has expended more than $250,000,000 for the improvement of inland navigation, and prospective expenditures will approximate several times this amount. It is obvious that the determination of stream flow is necessary to the intelligent solution of the many problems involved.

Irrigation.—The United States is now expending $51,000,000 on federal irrigation systems, and this amount is far exceeded by the private expenditures of this nature in the arid West. The integrity of any irrigation system depends absolutely on the amount of water available. Therefore investigations of stream flow in that portion of the country are not only of first importance in the redemption of the lands but constitute an insurance of federal and private investments.

Domestic water supply.—The highest use of water is for domestic supply, and although this branch of the subject is of less direct federal interest than the branches already named, it nevertheless has so broad a significance with respect to the general welfare that the Federal Government is ultimately and intimately concerned.

Water power.—The development of the water power of the country is an economic necessity. Our stock of coal is being rapidly depleted and the cost of steam power is increasing accordingly. Industrial growth and, as a consequence, the progress of the United States as a nation will cease if cheap power is not available. Water power affords the only avenue now open. When the electric transmission of power was accomplished the relation of our water powers to national economy changed entirely. Before the day of electric transmission water power was important only at the locality at which it was generated, but it has now become a public utility in which the individual citizen is vitally interested. Inasmuch as the amount of water power that may be made available depends on the flow of rivers, the investigation of flow becomes a prerequisite in the judicious management of this source of energy.

Drainage of swamp and overflowed lands.—More than 70,000,000 acres of the richest land in this country are now practically worthless or of precarious value by reason of overflow and swamp conditions. When this land is drained it becomes exceedingly productive and its value increases many fold. Such reclamation would add to the national assets at least $700,000,000. The study of run-off is the first consideration in connection with drainage projects. If by the drainage of a large area into any particular channel that channel becomes so gorged with water which it had not hitherto been called upon to convey that overflow conditions are created in places where previously the land was not subject to inundation, then drainage results merely in an exchange of land values. This is not the purpose of drainage improvement.

Flood prevention.—The damage from floods in the United States probably exceeds on the average $100,000,000 annually, and in the year 1908, according to estimates based on reliable data, the aggregate damage approximated $250,000,000. Such an annual tax on the property of great regions should be reduced in the orderly progress of government. It goes without saying that any consideration of flood prevention must be based on a thorough knowledge of stream flow, both in the contributing areas which furnish the water and along the great lowland rivers.

PUBLICATIONS.

The data on stream flow collected by the United States Geological Survey since its inception have appeared in the annual reports, bulletins, and water-supply papers. Owing to natural processes of evolution and to changes in governmental requirements, the character of the work and the territory covered by these different publications has varied greatly. For the purpose of uniformity in the presentation of reports a general plan has been agreed upon by the United States Reclamation Service, the United States Forest Service, the United States Weather Bureau, and the United States Geological Survey, according to which the area of the United States has been divided into twelve parts, whose boundaries coincide with certain natural drainage lines. The areas so described are indicated by the following list of papers on surface water supply for 1909. The dividing line between the North Atlantic and South Atlantic drainage areas lies between York and James rivers.

Papers on surface water supply of the United States, 1909.

Part.	No.	Title.	Part.	No.	Title.
I	261	North Atlantic coast.	VI	266	Missouri River Basin.
II	262	South Atlantic coast and eastern Gulf of Mexico.	VII	267	Lower Mississippi River Basin.
			VIII	268	Western Gulf of Mexico.
III	263	Ohio River Basin.	IX	269	Colorado River Basin.
IV	264	St. Lawrence River Basin.	X	270	Great Basin.
V	265	Upper Mississippi River and Hudson Bay basins.	XI	271	California.
			XII	272	North Pacific coast.

The following table gives the character of data regarding stream flow at regular stations to be found in the various publications of the United States Geological Survey exclusive of all special papers. Numbers of reports are inclusive, and dates also are inclusive so far as the data are available.

Stream-flow data in reports of the United States Geological Survey.

[Ann.=Annual Report; B.=Bulletin; W. S.=Water-Supply Paper.]

Report.	Character of data.	Year.
10th Ann., pt. 2	Descriptive information only	
11th Ann., pt. 2	Monthly discharge	1884 to Sept., 1890.
12th Ann., pt. 2	do	1884 to June 30, 1891.
13th Ann., pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th Ann, pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1888 to Dec. 31, 1893.
B. 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th Ann., pt. 2	Descriptive information only	
B. 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W. S. 11	Gage heights (also gage heights for earlier years)	1896.
18th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for some earlier years).	1895 and 1896.
W. S. 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W. S. 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W. S. 27	Measurements, ratings, and gage heights, eastern United States. eastern Mississippi River, and Missouri River.	1898.
W. S. 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th Ann., pt. 4	Monthly discharge (also for many earlier years)	1898
W. S. 35 to 39	Descriptions, measurements, gage heights, and ratings	1899
21st Ann., pt. 4	Monthly discharge	1899.
W. S. 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d Ann., pt. 4	Monthly discharge	1900.
W. S. 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W. S. 75	Monthly discharge	1901.
W. S. 82 to 85	Complete data	1902.
W. S. 97 to 100	do	1903.
W. S. 124 to 135	do	1904.
W. S. 165 to 178	do	1905.
W. S. 201 to 214	Complete data, except descriptions	1906.
W. S. 241 to 252	Complete data	1907-8.
W. S. 261 to 272	do	1909.

NOTE.—No data regarding stream flow are given in the 15th and 17th annual reports.

The records at most of the stations discussed in these reports extend over a series of years. An index of the reports containing records prior to 1904 has been published in Water-Supply Paper 119. The first table which follows gives, by years and drainage basins, the numbers of the papers on surface water supply published from 1899 to 1909. Wherever the data for a drainage basin appear in two papers the number of one is placed in parentheses and the portion of the basin covered by that paper is indicated in the second table. For example, in 1904 the data for Missouri River were published in Water-Supply Papers 130 and 131, and the portion of the records contained in Water-Supply Paper 131, as indicated by the second table, is that relating to Platte and Kansas rivers.

Numbers of water-supply papers containing results of stream measurements, 1899–1909.

	1899.[a]	1900.[b]	1901.	1902.	1903.	1904.	1905.	1906.	1907–8.	1909.
Atlantic coast and eastern Gulf of Mexico:										
New England rivers	35	47	65, 75	82	97	124	165	201	241	261
Hudson River to Delaware River, inclusive	35	47, (48)	65, 75	82	97	125	166	202	241	261
Susquehanna River to York River, inclusive	35	48	65, 75	82	97	126	167	203	241	261
James River to Yadkin River, inclusive	(35), 36	48	65, 75	(82), 83	(97), 98	126	167	203	242	262
Santee River to Pearl River, inclusive	36	48	65, 75	83	98	127	168	204	242	262
St. Lawrence River	36	49	65, 75	(82), 83	97	129	170	206	244	264
Hudson Bay	......	......	66, 75	85	100	130	171	207	245	265
Mississippi River:										
Ohio River	36	48, (49)	65, 75	83	98	128	169	205	243	263
Upper Mississippi River	36	49	65, 75	83	98, (99)	128, (130)	171	207	245	265
Missouri River	(36), 37	49, (50)	66, 75	84	99	130, (131)	172	208	246	266
Lower Mississippi River	37	50	(65), 66, 75	(83), 84	(98), 99	(128), 131	(169), 173	(205), 209	247	267
Western Gulf of Mexico	37	50	66, 75	84	99	132	174	210	248	268
Pacific coast and Great Basin:										
Colorado River	(37), 38	50	66, 75	85	100	133, (134)	175, (177)	211, (213)	249, (251)	269, (271)
Great Basin	38, (39)	51	66, 75	85	100	133, (134)	176, (177)	212, (213)	250, (251)	270, (271)
South Pacific coast to Klamath River, inclusive	(38), 39	51	66, 75	85	100	134	177	213	251	271
North Pacific coast	38	51	66, 75	85	100	135	(177), 178	214	252	272

---

[a] Rating tables and index to Water-Supply Papers 35-39 contained in Water-Supply Paper 39.

[b] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52.

Numbers of water-supply papers containing data covering portions of drainage basins.

No.	River basin.	Tributaries included.
35	James	
36	Missouri	Gallatin.
37	Colorado	Green, Gunnison, Grand above junction with Gunnison.
38	Sacramento	Except Kings and Kern.
39	Great Basin	Mohave.
48	Delaware	Wissahickon and Schuylkill.
49	Ohio	Scioto.
50	Missouri	Loup and Platte near Columbus, Nebr. All tributaries below junction with Platte.
65	Lower Mississippi	Yazoo.
82	James St. Lawrence	 Lake Ontario, tributaries to St. Lawrence River proper.
83	Lower Mississippi	Yazoo.
97	James	
98	Lower Mississippi	Do.
99	Upper Mississippi	Tributaries from the west.
128	Lower Mississippi	Yazoo.
130	Upper Mississippi	Tributaries from the west.
131	Missouri	Platte, Kansas.
134	Colorado Great Basin	Data near Yuma, Ariz., repeated. Susan, Owens, Mohave.
169	Lower Mississippi	Yazoo.
177	Colorado Great Basin North Pacific coast	Below junction with Gila. Susan repeated, Owens, Mohave. Rogue, Umpqua, Siletz.
205	Lower Mississippi	Yazoo, Homochitto.
213	Colorado Great Basin	Data at Hardyville repeated; at Yuma, Salton Sea. Owens, Mohave.
251	Colorado	Yuma and Salton Sea stations repeated.
271	Great Basin	Owens River basin.

The order of treatment of stations in any basin in these papers is downstream. The main stem of any river is determined on the basis of drainage area, local changes in name and lake surface being disregarded. After all stations from the source to the mouth of the main stem of the river have been given, the tributaries are taken up in regular order from source to mouth. The tributaries are treated the same as the main stream, all stations in each tributary basin being given before taking up the next one below.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated above, and in the records for large lakes, where it is often clearer to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups: (1) Those which represent a rate of flow, as second-feet, gallons per minute, miner's inches, and run-off in second-feet per square mile, and (2) those which represent the actual quantity of water, as run-off in depth in inches and acre-feet. They may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second and is the rate of discharge of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed by the use of the factors given in the following table of equivalents:

"Gallons per minute" is generally used in connection with pumping and city water supply.

The "miner's inch" is the rate of discharge of water that passes through an orifice 1 inch square under a head which varies locally. It is commonly used by miners and irrigators throughout the West and is defined by statute in each State in which it is used.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off in inches" is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

"Acre-foot" is equivalent to 43,560 cubic feet, and is the quantity required to cover an acre to the depth of 1 foot. It is commonly used in connection with storage for irrigation work.

CONVENIENT EQUIVALENTS.

The following is a list of convenient equivalents for use in hydraulic computations:

1 second-foot equals 40 California miner's inches (law of March 23, 1901).
1 second-foot equals 38.4 Colorado miner's inches.
1 second-foot equals 40 Arizona miner's inches.
1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,272 gallons for one day.
1 second-foot equals 6.23 British imperial gallons per second.
1 second-foot for one year covers 1 square mile 1.131 feet or 13.572 inches deep.
1 second-foot for one year equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one day covers 1 square mile 0.03719 inch deep.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet.
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 California miner's inches equal 18.7 United States gallons per second.
100 California miner's inches equal 96 Colorado miner's inches.
100 California miner's inches for one day equal 4.96 acre-feet.
100 Colorado miner's inches equal 2.60 second-feet.
100 Colorado miner's inches equal 19.5 United States gallons per second.
100 Colorado miner's inches equal 104 California miner's inches.
100 Colorado miner's inches for one day equal 5.17 acre-feet.
100 United States gallons per minute equal 0.223 second-foot.
100 United States gallons per minute for one day equal 0.442 acre-foot.
1,000,000 United States gallons per day equal 1.55 second-feet.
1,000,000 United States gallons equal 3.07 acre-feet.
1,000,000 cubic feet equal 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot equals 7.48 gallons.
1 cubic foot of water weighs 62.5 pounds.
1 cubic meter per minute equals 0.5886 second-foot.

1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1⅓ horsepower equal about 1 kilowatt.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ = net horsepower on water wheel realizing 80 per cent of theoretical power.

EXPLANATION OF TABLES.

For each drainage basin there is given a brief description of general conditions covering such features as area, source, tributaries, topography, geology, conditions of forestation, rainfall, ice conditions, irrigation, storage, power possibilities, and other special features of importance or interest.

For each regular current-meter gaging station are given in general, and so far available, the following data: Description of station, list of discharge measurements, table of daily gage heights, table of daily discharges, table of monthly and yearly discharges and run-off. For stations located at weirs or dams the gage-height table is omitted.

In addition to statements regarding the location and installation of current-meter stations, the descriptions give information in regard to any conditions which may affect the constancy of the relation of gage height to discharge, covering such points as ice, logging, shifting conditions of flow, and backwater; also information regarding diversions which decrease the total flow at the measuring section. Statements are also made regarding the accuracy and reliability of the data.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, name of hydrographer, width and area of cross section, gage height, and discharge in second-feet.

The table of daily gage heights gives the daily fluctuations of the surface of the river as found from the mean of the gage readings taken each day. At most stations the gage is read in the morning and in the evening. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. All gage heights during ice conditions, backwater from obstructions, etc., are published as recorded, with suitable footnotes. The rating is not applicable for such periods unless the proper corrections to the gage heights are known and applied. Attention is called to the fact that the zero of the gage is placed at an arbitrary datum and has no relation to zero flow or the bottom of the river. In general, the zero is located somewhat below the lowest known flow, so that negative readings shall not occur.

The discharge measurements and gage heights are the base data from which rating tables, daily discharge tables, and monthly discharge tables are computed.

The rating table gives, either directly or by interpolation, the discharge in second-feet corresponding to every stage of the river recorded during the period for which it is applicable. It is not published in this report, but can be determined from the daily gage heights and daily discharges for the purpose of verifying the published results as follows:

First plot the discharge measurements for the current and earlier years on cross-section paper with gage heights in feet as ordinates and discharge in second-feet as abscissas. Then tabulate a number of gage heights taken from the daily gage height table for the complete range of stage given and the corresponding discharges for the days selected from the daily discharge table and plot the values on cross-section paper. The last points plotted will define the rating curve used and will lie among the plotted discharge measurements. After drawing the rating curve, a table can be developed by scaling off the discharge in second-feet for each tenth foot of gage height. These values should be so adjusted that the first differences shall always be increasing or constant, except for known backwater conditions.

The table of daily discharges gives the discharges in second-feet corresponding to the observed gage heights as determined from the rating tables.

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge consequently larger than given in the maximum column. Likewise, in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet for each second during the month. On this the computations for the remaining columns, which are defined on page 11, are based.

FIELD METHODS OF MEASURING STREAM FLOW.

There are three distinct methods of determining the flow of open-channel streams: (1) By measurements of slope and cross section and the use of Chezy's and Kutter's formulas; (2) by means of a weir or dam; (3) by measurements of the velocity of the current and of the area of the cross section. The method chosen depends on the local physical conditions, the degree of accuracy desired, the funds available, and the length of time that the record is to be continued.

Slope method.—Much information has been collected relative to the coefficients to be used in the Chezy formula, $v=c\sqrt{Rs}$. This has been utilized by Kutter, both in developing his formula for c and in determining the values of the coefficient n which appears therein. The results obtained by the slope method are in general only roughly approximate, owing to the difficulty in obtaining accurate data and the uncertainty of the value for n to be used in Kutter's formula. The most common use of this method is in estimating the flood discharge of a stream when the only data available are the cross section, the slope as shown by marks along the bank, and a knowledge of the general conditions. It is seldom used by the United States Geological Survey. For full information regarding this method the reader is referred to the various text-books on hydraulics.

Weir method.—Relatively few stations are maintained at weirs or dams by the United States Geological Survey. Standard types of sharp-crested and broad-crested weirs, within the limits for which accurate coefficients have been experimentally obtained, give very accurate records of discharge if properly maintained. At practically all broad-crested weirs, however, there is a diversion of water either through or around the dam, usually for the purpose of development of water power. The flow is often complicated and the records are subject to errors from such sources as leakage through the dam, backwater at high stages, uncertainty regarding coefficient, irregularity of crest, obstructions from logs or ice, use of flashboards, old turbines with imperfect ratings, and many others, depending on the type of development and the uses of the diverted water.

In general, records of discharge at dams are usually accurate enough for practical use if no others are available. It has been the general experience of the United States Geological Survey, however, that records at current-meter gaging stations under unobstructed-channel conditions are more accurate than those collected at dams and where the conditions are reasonably favorable are practically as good as those obtained at sharp-crested weirs.[1]

Velocity method.—Streams in general present throughout their courses to a greater or less extent all conditions of permanent, semi-permanent, and varying conditions of flow. In accordance with the location of the measuring section with respect to these physical conditions current-meter gaging stations may in general be divided into four classes—(1) those with permanent conditions of flow; (2) those with beds which change only during extreme high water;

---

[1] The determination of discharge over the different types of weirs and dams is treated fully in "Weir experiments, coefficients, and formulas" (Water-Supply Paper 200) and in the various text-books on hydraulics. "Turbine water-wheel tests and power tables" (Water-Supply Paper 180) treats of the discharge through turbines when used as meters. The edition of the latter water-supply paper is nearly exhausted. The paper can, however, be consulted at most of the larger libraries of the country or it can be obtained from the Superintendent of Documents, Washington, D. C., at a cost of 20 cents.

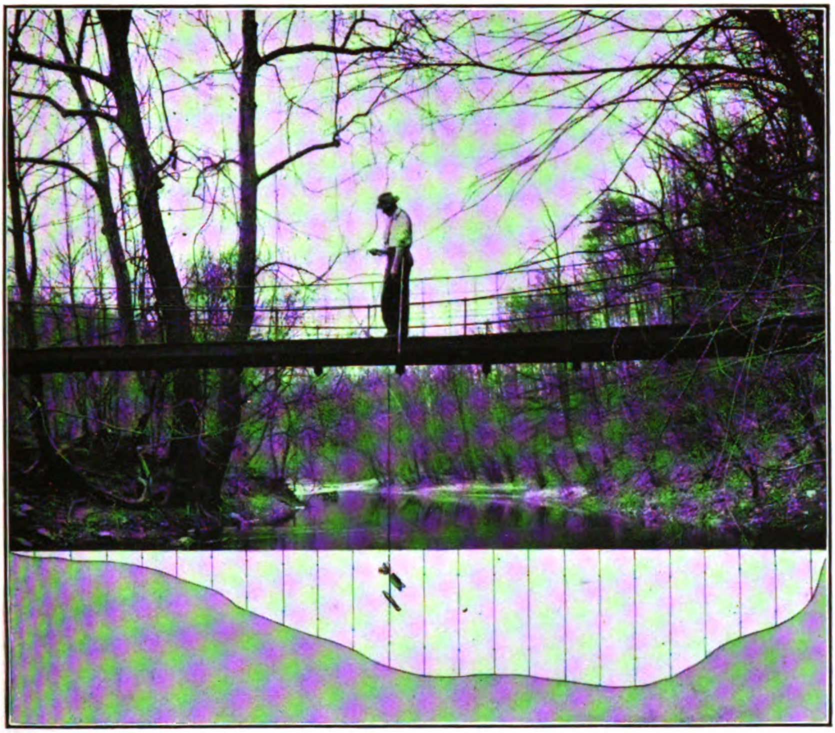
(3) those with beds which change frequently but which do not cause a variation of more than about 5 per cent of the discharge curves from year to year; and (4) those with constantly shifting beds. In determining the daily flow different office methods are necessary for each class. The field data on which the determinations are based and the methods of collecting them are, however, in general the same.

Great care is taken in the selection and equipment of gaging stations for determining discharge by velocity measurements in order that the data may have the required degree of accuracy. They are located, as far as possible, at such points that the relation between gage height and discharge will always remain constant for any given stage. The experience of engineers of the Geological Survey has been that permanency of conditions of flow is the prime requisite of any current-meter gaging station when maintained for several years, unless funds are available to cover all changes in conditions of flow. A straight, smooth section, without cross currents, backwater, boils, etc., at any stage is highly desirable, but on most streams is not attainable except at the expense of a cable equipment. Rough, permanent sections, if measurements are properly made by experienced engineers, taking measuring points at a distance apart of 5 per cent or less of the total width, will within reasonable limits yield better results for a given outlay of money than semipermanent or shifting sections with smooth, uniform current. So far as possible, stations are located where the banks are high and not subject to overflow at high stages and out of the influence of tributary streams, dams, or other artificial obstructions which might affect the relation between gage height and discharge.

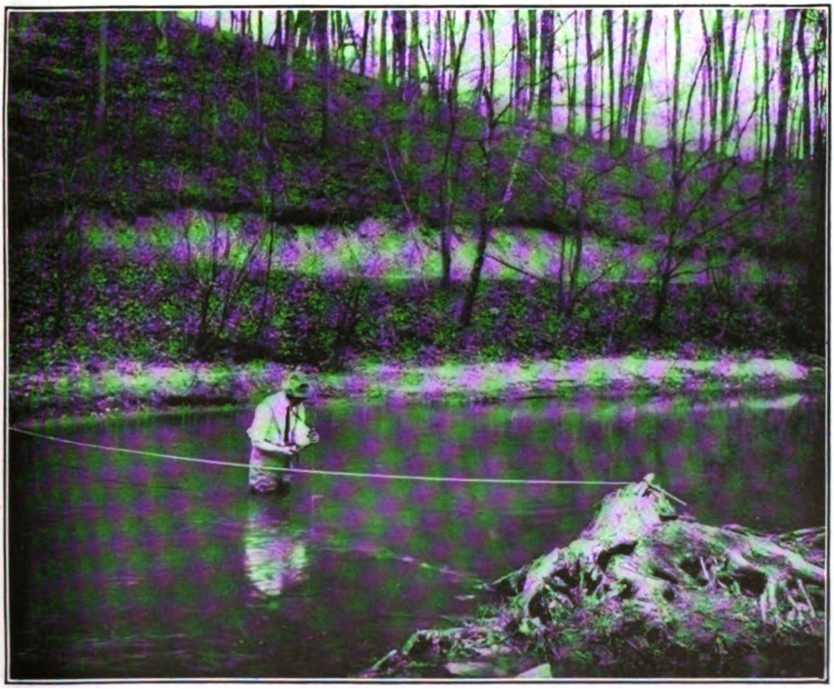
A gaging station consists essentially of a gage for determining the daily fluctuations of stage of the river and some structure or apparatus from which discharge measurements are made, usually a bridge or cable.

The two factors required to determine the discharge of a stream past a section perpendicualr to the mean direction of the current are the area of the cross section and the mean velocity of flow normal to that section.

In making a measurement with a current meter a number of points, called measuring points, are measured off above and in the plane of the measuring section at which observations of depth and velocity are taken. (See Pl. I, *A*.) These points are spaced equally for those parts of the section where the flow is uniform and smooth, and are spaced unequally for other parts, according to the discretion and judgment of the engineer. In general, the points should not be spaced farther apart than 5 per cent of the channel width, nor farther apart than the approximate mean depth of the section at the time of measurement.



A. FOR BRIDGE MEASUREMENT.



B. FOR WADING MEASUREMENT.

TYPICAL GAGING STATIONS.

The measuring points divide the total cross section into elementary strips, at each end of which observations of depth and velocity are made. The discharge of any elementary strip is the product of the average of the depths at the two ends times the width of the strip times the average of the mean velocities at the two ends of the strip. The sum of the discharges of the elementary strips is the total discharge of the stream.[1]

Depths for the determination of the area are usually obtained by sounding with the current meter and cable. In rough sections or swift current an ordinary weight and cable are used, particular care being taken that all observations shall be in the plane of the cross section.

Two methods of determining the velocity of flow of a stream are in general use—the float method and the current-meter method.

The float method, with its various modifications of surface, subsurface, and tube or rod floats, is now considered obsolete in the ordinary practice of the United States Geological Survey. The use of this method is limited to special conditions where it is impracticable to use the current meter, such as in places where large quantities of ice or débris which may damage the meter are flowing with the current, and for miscellaneous measurements or other work where a high degree of accuracy is not necessary. Tube floats are very satisfactory for use in canals with regular bottoms and even flow of current. Measurements by the float method are made as follows: The velocity of flow of the stream is obtained by observing the time which it takes floats set free at different points across the stream to pass between two range lines about 200 feet apart. The area used is the mean value obtained from several cross sections measured between the two range lines. The chief disadvantages of this method are difficulty in obtaining the correct value of mean area for the course used and uncertainty regarding the proper coefficient to apply to the observed velocity.[2]

The Price current meter is now used almost to the exclusion of other types of meters by the United States Geological Survey in the determination of the velocity of flow of water in open channels, a use for which it is adapted under practically all conditions.[3]

Plate II shows in the center the new type of penta-recording current meter equipped for measurements at bridge and cable stations; on the left the same type of meter is shown equipped for wading measurements, to record by the acoustic method; the meter shown on the right is equipped to record electrically. (See Pl. I, *B.*) Briefly, the meter consists of six cups attached to a vertical shaft which revolves on a conical hardened-steel point when immersed in moving water. The revolutions are indicated electrically. The rating or relation between the velocity of the moving water and the revolutions of the wheel is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity per second of moving water for any number of revolutions in a given time interval. The ratio of revolutions per second to velocity of flow in feet per second is very nearly a constant for all speeds, and is approximately 0.45.

---

[1] For a discussion of methods of computing the discharge of a stream see Engineering News, June 25, 1908.

[2] Further information regarding this method is given in Water-Supply Paper 95 and in the various textbooks covering the general subject of stream flow. The edition of this paper is nearly exhausted. It can, however, be consulted at most of the larger libraries of the country, or can be obtained from the Superintendent of Documents, Washington, D. C., at a cost of 15 cents.

[3] See Hoyt, J. C., and others, use and care of the current meter as practiced by the United States Geological Survey: Trans. Am. Soc. C. E., vol. 66, 1910, p. 70.

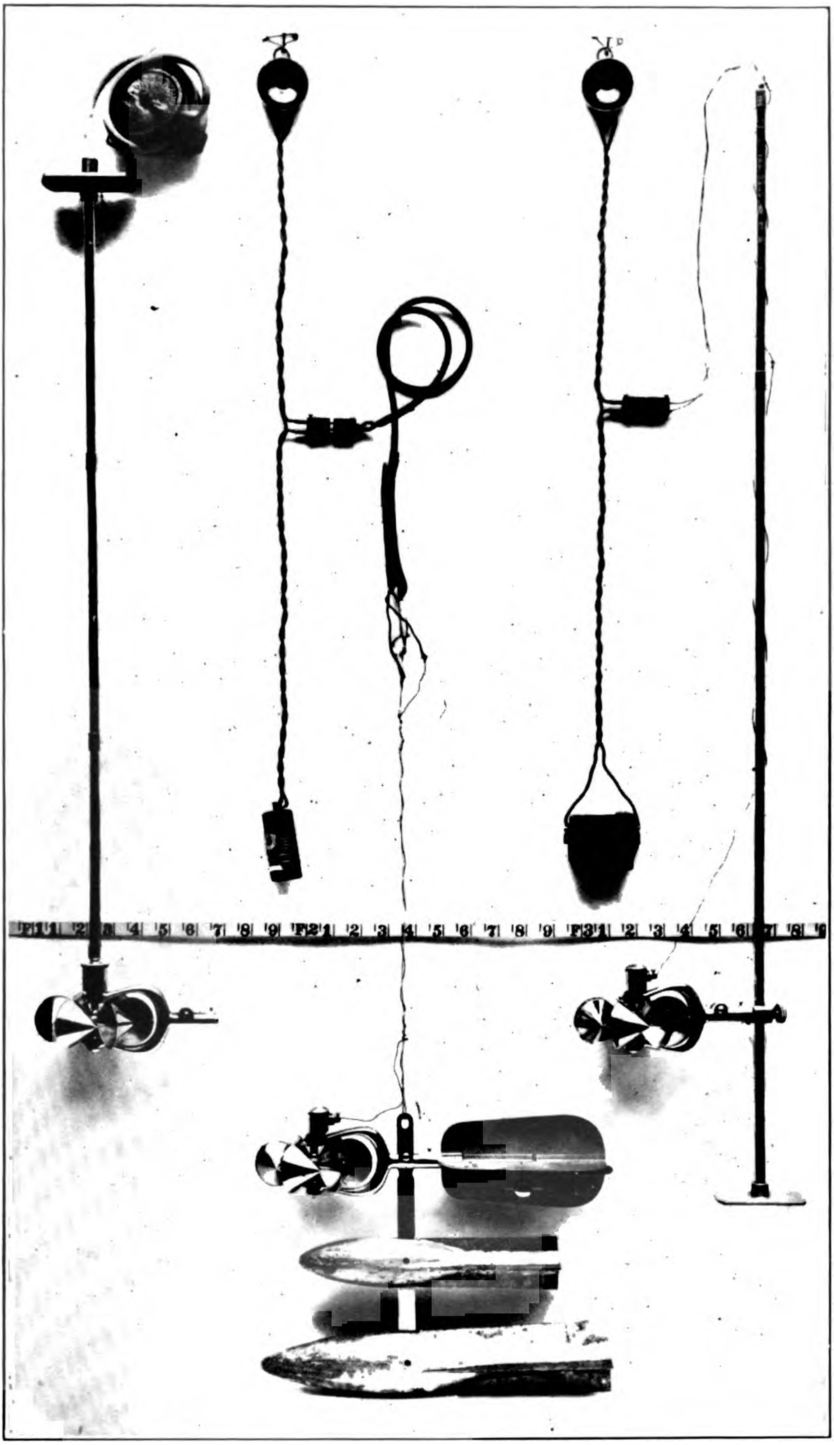
Three classes of methods of measuring velocity with current meters are in general use—multiple-point, single-point, and integration.

The two principal multiple-point methods in general use are the vertical velocity curve and 0.2 and 0.8 depth.

In the vertical velocity curve method a series of velocity determinations are made in each vertical at regular intervals, usually about 10 to 20 per cent of the depth apart. By plotting these velocities as abscissas and their depths as ordinates and drawing a smooth curve among the resulting points, the vertical velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. This method of obtaining the mean velocity in the vertical is probably the best known, but on account of the length of time required to make a complete measurement its use is largely limited to the determination of coefficients for purposes of comparison and to measurements under ice.

In the second multiple-point method the meter is held successively at 0.2 and 0.8 depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. (See Pl. I, *A.*) On the assumption that the vertical velocity curve is a common parabola with horizontal axis, the mean of the velocities at 0.22 and 0.79 depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this multiple-point method gives the mean velocity very closely for open-water conditions and that in a completed measurement it seldom varies as much as 1 per cent from the value given by the vertical velocity curve method. Moreover, the indications are that it holds nearly as well for ice-covered rivers. It is very extensively used in the regular practice of the United States Geological Survey.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth



SMALL PRICE CURRENT METERS.

for which the coefficient for reducing to mean velocity has been determined or must be assumed.

Extensive experiments by means of vertical velocity curves show that the thread of mean velocity generally occurs between 0.5 and 0.7 total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and at this point the meter is held in most of the measurements made by the single-point method. A large number of vertical velocity curve measurements, taken on many streams and under varying conditions, show that the average coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity. The variation of the coefficient from unity in individual cases is, however, greater than in the 0.2 and 0.8 method and the general results are not as satisfactory.

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the effect of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocity taken at the subsurface to the mean has been found to be in general from about 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is especially adapted for flood measurements or when the velocity is so great that the meter can not be kept in the correct position for the other methods.

The vertical-integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface and noting the number of revolutions and the time taken in the operation. This method has the advantage that the velocity at each point of the vertical is measured twice. It is useful as a check on the point methods. In using the Price meter great care should be taken that the vertical movement of the meter is not rapid enough to vitiate the accuracy of the resulting velocity.

The determination of the flow of an ice-covered stream is difficult, owing to diversity and instability of conditions during the winter period and also to lack of definite information in regard to the laws of flow of water under ice. The method now employed is to make frequent discharge measurements during the frozen periods by the 0.2 and 0.8 and the vertical velocity curve methods, and to keep an accurate record of the conditions, such as the gage height to the surface of the water as it rises in a hole cut in the ice, and the thickness and character of the ice. From these data an approximate estimate of the daily flow can be made by constructing a rating curve (really a series of curves) similar to that used for open channels, but considering, in addition to gage heights and discharge, the varying thickness of ice.[1]

---

[1] For information in regard to flow under ice cover see Water-Supply Paper U. S. Geol. Survey No. 187, 1907.

OFFICE METHODS OF COMPUTING AND STUDYING DISCHARGE AND RUN-OFF.

At the end of each year the field or base data for current-meter gaging stations, consisting of daily gage heights, discharge measurements, and full notes, are assembled. The measurements are plotted on cross-section paper and rating curves are drawn wherever feasible. The rating tables prepared from these curves are then applied to the tables of daily gage heights to obtain the daily discharges, and from these applications the tables of monthly discharge and run-off are computed.

Rating curves are drawn and studied with special reference to the class of channel conditions which they represent. The discharge measurements for all classes of stations when plotted with gage heights in feet as ordinates and discharges in second-feet as abscissas define rating curves which are generally more or less parabolic in form. In many cases curves of area in square feet and mean velocity in feet per second are also constructed to the same scale of ordinates as the discharge curve. These are used mainly to extend the discharge curves beyond the limits of the plotted discharge measurements and for checking purposes to avoid errors in the form of the discharge curve and to determine and eliminate erroneous measurements.

For every rating table the following assumptions are made for the period of application of the table: (*a*) That the discharge is a function of and increases gradually with the stage; (*b*) that the discharge is the same whenever the stream is at a given stage, and hence such changes in conditions of flow as may have occurred during the period of application are either compensating or negligible, except that the rating is not applicable for known conditions of ice, log jams, or other similar obstructions; (*c*) that the increased and decreased discharge due to change of slope on rising and falling stages is either negligible or compensating.

As already stated, the gaging stations may be divided into several classes, as indicated in the following paragraphs:

The stations of class 1 represent the most favorable conditions for an accurate rating and are also the most economical to maintain. The bed of the stream is usually composed of rock and is not subject to the deposit of sediment and loose material. This class includes also many stations located in a pool below which is a permanent rocky riffle that controls the flow like a weir. Provided the control is sufficiently high and close to the gage to prevent cut and fill at the gaging point from materially affecting the slope of the water surface, the gage height will for all practical purposes be a true index of the discharge. Discharge measurements made at such stations usually plot within 2 or 3 per cent of the mean discharge curve, and the rating developed from that curve represents a very high degree of accuracy. Stations of this type are found in the north Atlantic coast drainage basins.

Class 2 is confined mainly to stations on rough mountainous streams with steep slope. The beds of such streams are, as a rule, comparatively permanent during low and medium stages, and when the flow is sufficiently well defined by an adequate number of discharge measurements before and after each flood the stations of this class give nearly as good results as those of class 1. As it is seldom possible to make measurements covering the time of change at flood stage, the assumption is often made that the curves before and after the flood converged to a common point at the highest gage height recorded during the flood. Hence the only uncertain period occurs during the few days of highest gage heights covering the period of actual change in conditions of flow. Stations of this type are found in the upper Missouri River drainage basin.

Class 3 includes most of the current-meter gaging stations maintained by the United States Geological Survey. If sufficient measurements could be made at stations of this class results would be obtained nearly equaling those of class 1, but owing to the limited funds at the disposal of the Survey this is manifestly impossible, nor is it necessary for the uses to which discharge data are applied. The critical points are as a rule at relatively high or low stages. The percentage error, however, is greater at low stages. No absolute rule can be laid down for stations of this class. Each rating curve must be constructed mainly on the basis of the measurements of the current year, the engineer being guided largely by the past history of the station and the following general law. If all measurements ever made at a station of this class are plotted on cross-section paper, they will define a mean curve which may be called a "standard curve." It has been found in practice that if after a change caused by high stage a relatively constant condition of flow occurs at medium and low stages, all measurements made after the change will plot on a smooth curve which is practically parallel to the standard curve with respect to ordinates, or gage heights. This law of the parallelism of ratings is the fundamental basis of all ratings and estimates at stations with semipermanent and shifting channels. It is not absolutely correct, but, with few exceptions, answers all the practical requirements of estimates made at low and medium stages after a change at a high stage. This law appears to hold equally true whether the change occurs at the measuring section or at some controlling point below. The change is, of course, fundamentally due to change in the channel caused by cut or fill, or both, at or near the measuring section. For all except small streams the changes in section usually occur at the bottom. The following simple but typical examples illustrate this law:

(*a*) If 0.5 foot of planking were to be nailed on the bottom of a well-rated wooden flume of rectangular section, there would result, other conditions of flow being equal, new curves of discharge, area, and velocity, each plotting 0.5 foot above the original curves when referred to the original gage. In other words, this condition would be analogous to a uniform fill or cut in a river channel which either reduces or increases all three values of discharge, area, and velocity for any given gage height. In practice, however, such ideal conditions rarely exist.

(*b*) In the case of a cut or fill at the measuring section there is a marked tendency toward decrease or increase, respectively, of the velocity. In other words, the velocity has a compensating effect, and if the compensation is exact at all stages the discharge at a given stage will be the same under both the new and the old conditions.

(*c*) In the case of uniform change along the crest of a weir or rocky control, the area curve will remain the same as before the change, and it can be shown that here again the change in velocity curve is such that it will produce a new discharge curve essentially parallel to the original discharge curve with respect to their ordinates.

Of course, in actual practice such simple changes of section do not occur. The changes are complicated and lack uniformity, a cut at one place being largely offset by a fill at another, and vice versa. If these changes are very radical and involve large percentages of the total area—as, for example, on small streams—there may result a wide departure from the law of parallelism of ratings. In complicated changes of section the corresponding changes in velocity which tend to produce a new parallel discharge curve may interfere with each other materially, causing eddies, boils, backwater, and radical changes in slope. In such extreme conditions, however, the measuring section would more properly fall under class 4 and would require very frequent measurements of discharge. Special stress is laid on the fact that, in the lack of other data to the contrary, the utilization of this law will yield the most probable results.

Slight changes at low or medium stages of an oscillating character are usually averaged by a mean curve drawn among them parallel to the standard curve, and if the individual measurements do not vary more than 5 per cent from the rating curve the results are considered good for stations of this class. Stations of this type are found in the south Atlantic coast and eastern Gulf of Mexico drainage basins.

Class 4 comprises stations that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency varying from a measurement every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow. These measurements are plotted and a mean or standard curve drawn among them. It is assumed that there is a different rating curve for every day of the year and that this rating is parallel to the standard curve with respect to their ordinates. On the day of a measurement the rating curve for that day passes through that measurement. For days between successive measurements it is assumed that the rate of change is uniform, and hence the ratings for the intervening days are equally spaced between the ratings passing through the two measurements. This method must be modified or abandoned altogether under special conditions. Personal judgment and a knowledge of the conditions involved can alone dictate the course to pursue in such cases. Stations of this type are found in the Platte, Arkansas, Rio Grande, and lower Colorado drainage basins.

The computations have, as a rule, been carried to three significant figures. Computation machines, Crelle's tables, and the 20-inch slide rule have been generally used. All computations are carefully checked.

After the computations have been completed they are entered in tables and carefully studied and intercompared to eliminate or account for all gross errors so far as possible. Missing periods are filled in, so far as is feasible, by means of comparison with adjacent streams. The attempt is made to complete years or periods of discharge, thus eliminating fragmentary and disjointed records. Full notes accompanying such estimates follow the daily and monthly discharge tables.

For most of the northern stations estimates have been made of the monthly discharge during frozen periods. These are based on measurements under ice conditions whenever available, daily records of temperature and precipitation obtained from the United States Weather Bureau, climate and crop reports, observers' notes of conditions, and a careful and thorough intercomparison of results with adjacent streams. Although every care possible is used in making these estimates, they are often very rough, the data for some of them being so poor that the estimates are liable to as much as 25 to 50 per cent error. It is believed, however, that estimates of this character are better than none at all, and serve the purpose of indicating in a relative way the proportionate amount of flow during the frozen period. These estimates are, as a rule, included in the annual discharge. The large error of the individual months has a relatively small effect on the annual total, and it is for many purposes desirable to have the yearly discharge computed, even though some error is involved in doing so.

ACCURACY AND RELIABILITY OF FIELD DATA AND COMPARATIVE RESULTS.

Practically all discharge measurements made under fair conditions are well within 5 per cent of the true discharge at the time of observation. Inasmuch as the errors of meter measurements are largely compensating, the mean rating curve, when well defined, is much more accurate than the individual measurements. Numerous tests and experiments have been made to test the accuracy of current-meter work. These show that it compares very favorably with the results from standard weirs and, owing to simplicity of methods, usually gives results that are much more reliable than those from stations at dams, where uncertainty regarding the coefficient and complicated conditions of flow prevail.

The work is, of course, dependent on the reliability of the observers. With relatively few exceptions, the observers perform their work honestly. Care is taken, however, to watch them closely and to inquire into any discrepancies. It is, of course, obvious that one gage reading a day does not always give the mean height for that day. As an almost invariable rule, however, errors from this source are compensating and virtually negligible in a period of one month, although a single day's reading may, when taken by itself, be considerably in error.

The effort is made to visit every station at least once each year for the purpose of making a measurement to determine the constancy of conditions of flow since the last measurement made during the preceding year, and also to check the elevation of the gage. On account of lack of funds or for other causes some stations were not visited during the current year. If conditions of flow have been reasonably permanent up to the time of the last preceding measurement, it is considered best to publish values of discharge on the basis of the latest verified rating curve rather than to omit them altogether, although it should be distinctly understood that such records are at times subject to considerable error. This is also true, although to a less degree, of the period of records since the date of the last measurement of the current year. As a rule, the accuracy notes are based on the assumption that the rating curve used is strictly applicable to the current year.

In order to give engineers and others information regarding the probable accuracy of the computed results, footnotes are added to the daily discharge tables, stating the probable accuracy of the rating tables used, and an accuracy column is inserted in the monthly discharge table. For the rating tables "well defined" indicates, in general, that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined" or "approximate," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The accuracy column in the monthly discharge table does not apply to the maximum or minimum nor to any individual day, but to the monthly mean. It is based on the accuracy of the rating, the probable reliability of the observer, and knowledge of local conditions. In this column, A indicates that the mean monthly flow is probably accurate within 5 per cent; B, within 10 per cent; C, within 15 per cent; D, within 25 per cent. Special conditions are covered by footnotes.

USE OF THE DATA.

In general, the policy is followed of making available for the public the base data which are collected in the field each year by the Survey engineers. This is done to comply with the law, and also for the express purpose of giving to any engineer the opportunity of examining the computed results and of changing and adjusting them as may seem best to him. Although it is believed that the rating tables and computed monthly discharges are as good as the base data up to and including the current year will warrant, it should always be borne in mind that the additional data collected at each station from year to year nearly always throw new light on data already collected and published, and hence allow more or less improvement in the computed results of earlier years. It is therefore expected that the engineer who makes serious use of the data given in these papers will verify all ratings and make such adjustments in earlier years as may seem necessary. The work of compiling, studying, revising, and republishing data for different drainage basins for five or ten year periods or more is carried on by the United States Geological Survey so far as the funds for such work are available.

The values in the table of monthly discharge are so arranged as to give only a general idea of the conditions of flow at the station, and it is not expected that they will be used for other than preliminary estimates.

The daily discharges are published to allow a more detailed study of the variation in flow and to determine the periods of deficient flow.

COOPERATIVE DATA.

Cooperative data of various kinds and data regarding the run-off at many stations maintained wholly by private funds are incorporated in the surface water-supply reports of the United States Geological Survey.

Many stations throughout the country are maintained for specific purposes by private parties who supply the records gratuitously to the United States Geological Survey for publication. When such records are supplied by responsible parties and appear to be reasonably accurate, they are verified, so far as possible, and estimated values of accuracy are given. Records clearly known to be worthless or misleading are not published. As it is, however, impossible to completely verify all such records furnished—because of lack of funds or for other causes—they are published for what they are worth, as they are of value as a matter of record and afford at least approximate information regarding stream flow at the particular localities. The Survey does not, however, assume any responsibility for inaccuracies found in such records, although most of them are believed to be reasonably good.

COOPERATION AND ACKNOWLEDGMENTS.

Special acknowledgments are due the following parties for assistance rendered and records furnished:

The International Boundary Commission—Gen. Anson Mills, commissioner on the part of the United States; Señor Don Jacobo Blanco, commissioner on the part of Mexico; and W. W. Follett, consulting engineer on the part of the United States.

The Territorial engineer of New Mexico, Mr. V. L. Sullivan, who has taken great interest in this work and done everything possible to promote cooperation. During 1909 the Territory spent $2,500, which was set aside specifically for the work throughout New Mexico, in addition to some other funds of the Territorial engineer's office.

The State engineer of Colorado, Mr. Charles W. Comstock, who paid the salaries of the observers and the expenses of the hydrographers at a number of stations in Colorado.

The Atchison, Topeka & Santa Fe Railway Co., which donated $1,000 to be spent in New Mexico in 1909 by the Territorial engineer in cooperation with the United States Geological Survey.

The Farmers Union Irrigation Co., which paid the expense of obtaining a record on the Rio Grande at the Thirty Mile Bridge, under the direction of their engineers.

The Rio Mimbres Irrigation Co., which donated $250 toward the installation and maintenance of an automatic gage on Mimbres River.

The United States Reclamation Service, which furnished the records on the lower Pecos River in New Mexico.

The United States Weather Bureau, the United States Forest Service, and many engineers and companies.

DIVISION OF WORK.

The field data in the Rio Grande drainage basin, except for those stations maintained by the International Boundary Commission, were collected under the direction of W. B. Freeman, district engineer, assisted by J. B. Stewart, G. H. Russell, and W. H. Sutton. The New Mexico work has been handled under the more immediate direction of Vernon L. Sullivan, Territorial engineer, assisted by C. D. Miller and others.

The data furnished by the International Water Commission were computed under the direction of W. W. Follett from the discharge measurements.

The data, ratings, and special studies of the completed data of the stations maintained by the United States Geological Survey were prepared by W. B. Freeman and R. H. Bolster. The computations and the preparation of the completed data for publication were made by G. C. Stevens, R. C. Rice, J. G. Mathers, H. D. Padgett, M. I. Walters, M. E. McChristie, and L. T. King.

The entire report was edited by Mrs. B. D. Wood.

GAGING STATIONS MAINTAINED IN WESTERN GULF OF MEXICO DRAINAGE BASINS.

The following list comprises the gaging stations regularly maintained in western Gulf of Mexico drainage basins by the United States Geological Survey and cooperative parties. Data for these stations have appeared in the published reports as shown in tables on pages 8–10. The stations are arranged by river basins, appear in downstream order, tributaries of main streams being indicated by indention. (See p. 11.)

- Sabine River near Longview, Tex., 1904–1906.
- Sabine River at Logansport, La., 1903–1906.
  - Neches River at Evadale, Tex., 1904–1906.
- Trinity River at Dallas, Tex., 1903–1906.
- Trinity River at Riverside, Tex., 1903–1906.
- Brazos River at Waco, Tex., 1898–1906.
- Brazos River at Richmond, Tex., 1903–1906.
- Colorado River at Austin, Tex., 1895–1906.
- Colorado River at Columbus, Tex., 1902–1906.
  - San Saba River near San Saba, Tex., 1904–1906.
- Guadalupe River near Cuero, Tex., 1903–1906.
- Rio Grande:
  - Rio Grande at Thirtymile Bridge, near Creede, Colo., 1909.
  - Rio Grande near Creede (Wason), Colo., 1907–1909.
  - Rio Grande near Del Norte, Colo., 1889–1909, except 1907.
  - Rio Grande near Lobatos (Cenicero), Colo., 1899–1909.
  - Rio Grande near Alamosa, Colo., 1894, 1895, 1903.
  - Rio Grande near Embudo, N. Mex., 1889–1903.
  - Rio Grande near Buckman, N. Mex. (Rio Grande near San Ildefonso), 1895–1905 and 1909.
  - Rio Grande near San Marcial, N. Mex., 1895–1909.
  - Rio Grande near El Paso, Tex., 1889–1893, 1897–1909.
  - Rio Grande near Fort Hancock, Tex., 1900–1903.
  - Rio Grande above and below Presidio, Tex., 1900–1909.

Rio Grande—Continued.
- Rio Grande near Langtry, Tex., 1900–1909.
- Rio Grande near Devils River (below mouth), Tex., 1900–1909.
- Rio Grande near Eagle Pass, Tex., 1900–1909.
- Rio Grande near Nuevo Laredo, Tamaulipas, Mexico, 1900–1903.
- Rio Grande near Laredo, Tex., 1903–1909.
- Rio Grande near Roma, Tex., 1900–1909.
- Rio Grande near Brownsville, Tex., 1900–1909.
  - Conejos River near Mogote, Colo., 1899, 1900, 1903–1909.
  - Chama River near Abiquia, N. Mex., 1895–1897.
  - Santa Fe Creek at Santa Fe, N. Mex., 1907–1909.
  - Mimbres River near Faywood, N. Mex., 1908–1909.
    - Cameron Creek at Fort Bayard, N. Mex., 1907–1909.
    - Stephens Creek at Fort Bayard, N. Mex., 1907–1909.
  - Pecos River at Santa Rosa, N. Mex., 1903–1906.
  - Pecos River near Fort Sumner, N. Mex., 1904–1909.
  - Pecos River near Roswell, N. Mex., 1903–1906.
  - Pecos River near Dayton, N. Mex., 1905–1909.
  - Pecos River near Lakewood, N. Mex., 1906–1909.
  - Pecos River at Avalon, N. Mex., 1906–1907.
  - Pecos River at Carlsbad, N. Mex., 1903–1908.
  - Pecos River near Pecos, Tex., 1898–1907.
    - Marguerreta flume near Pecos, Tex., 1898, 1900–1908.
  - Pecos River near Moorhead, Tex., 1900–1909.
  - Pecos River at High Bridge, near Lozier, Tex., 1898.
    - Gallinas River near Las Vegas, N. Mex., 1903–1909.
    - Taylor Moore ditch near Roswell, N. Mex., 1905.
    - Hondo River below Hondo reservoir, N. Mex., 1903–1906.
    - Hondo reservoir inlet near Hondo reservoir, N. Mex., 1906–1908.
    - Hondo reservoir scour gage No. 1 near Hondo reservoir, N. Mex., 1906.
    - Hondo River near Roswell, N. Mex., 1903–1906.
    - Penasco River near Dayton, N. Mex., 1905–1908.
    - Lake McMillan at Lakewood, N. Mex., 1906–1907 and 1909.
  - Devils River near Devils River, Tex., 1900–1909.
  - Rio Salado at Guerrero, Tamaulipas, Mexico, 1900–1909.
  - Rio San Juan at La Quemada, Tamaulipas, Mexico, 1900–1902.
  - Rio San Juan at Santa Rosalia Ranch, Tamaulipas, Mexico, 1902–1909.

RIO GRANDE DRAINAGE BASIN.

GENERAL FEATURES.

The Rio Grande basin is a long, narrow strip of country extending from the southern part of Colorado southeastward to the Gulf of Mexico. The perennial supply of water for the upper third of this basin comes principally from a comparatively small area of about 2,000 square miles of lofty mountains in Colorado and the extreme northern part of New Mexico. The Conchos enters the river from the Mexican side some 200 miles below El Paso and brings a good perennial flow as well as enormous floods in the summer and fall. Pecos and Devils rivers and springs also substantially augment the perennial supply, and other tributaries frequently furnish flood discharges, so that the "lower river" is not dependent on the mountain area for its perennial flow. The flood season above the Conchos is May and June; below it is August and September. Frequently the river is dry at El Paso when the lower river country is inundated. In addition to the areas contributing a perennial supply of water and a spasmodic supply, a vast area of "lost river" basins which supply no water at any time, may, from topographic considerations, be included within this great catchment basin.

The Rio Grande rises in the mountainous area to the south and east of the Continental Divide in southwestern Colorado, flows eastward for a time as a mountain stream, and enters the San Luis Valley about 80 miles below its source. In this valley it receives from the north the waters of Saguache and San Luis rivers, by seepage, if at all; from the west, near the lower end of the valley, Alamos, La Jara, and Conejos rivers; and from the east the Trinchera, Culebra, and Rio Costilla. About 4 miles north of the Colorado State line it enters a long canyon locally known as the Rio Grande Canyon. From the east there enter this canyon two tributaries, Red River and Rio Hondo.

The general slope of the valley is still toward the south, the river descending, however, more rapidly than the surface of the country. This canyon is 300 or 400 feet deep in places, appearing from above as a gash in an otherwise level mesa. Its south end is 3 miles above Embudo, N. Mex., where the walls open and the river enters the Espanola Valley. While in the valley above Embudo the river receives from the east Taos River, Embudo Creek, and other small streams, and in the Espanola Valley it is increased by the Chama, flowing in from the west, and by a number of streams from the east.

At the lower end of Espanola Valley the river passes through White Rock Canyon, a gorge in a range of hills stretching from the Jemez to the Santa Fe Mountains. From Pena Blanca, near the lower end of this canyon, nearly to Socorro, the river flows in a valley from 1 to 3 miles wide, bounded on each side by mesas from 300 to 600 feet above the river. About 20 miles below Pena Blanca the Jemez enters from the west, and 60 miles or more below Albuquerque the Puerco comes in from the same side. The latter is a torrential stream with no perennial flow. Below these streams the Rio Grande has no tributaries of note until the Pecos comes in about 400 miles by river below El Paso.

At and below Socorro the valley contracts until it becomes too narrow for agriculture, but from San Antonio to San Marcial its width ranges from 1 to 2 miles. Below San Marcial the river swings to the west around the Cristobal and Caballos mountains, which lie along the west edge of the Jornada del Muerto, the valley from San Marcial to Rincon being narrow, low, and marshy. At Rincon the river enters a canyon which extends to Fort Selden, a distance of 15 miles. The Mesilla Valley, the most fertile valley in New Mexico, begins below Fort Selden and extends to the pass above El Paso, a distance of over 50 miles. Above El Paso the banks of the river again assume the canyon-like character for 3 miles, and the river passing this enters the Ysleta Valley, now commonly called the El Paso Valley.

The canyons above these valleys are not cut into hard, indurated rocks, but are bordered in many places by steep walls of comparatively soft, friable sandstones, alternating with conglomerates or beds of clay, the whole series in the northern part of New Mexico, at least, being capped by a vesicular lava. The fall through these canyons being great, the down-cutting is rapid, and thus the waters are supplied constantly with fresh detritus, part of which is deposited in turn in the valley below.

From El Paso to the Gulf the river forms the boundary between Mexico and the United States.

From source to mouth the Rio Grande is nearly 2,000 miles long, and its drainage area comprises about 248,000 square miles.

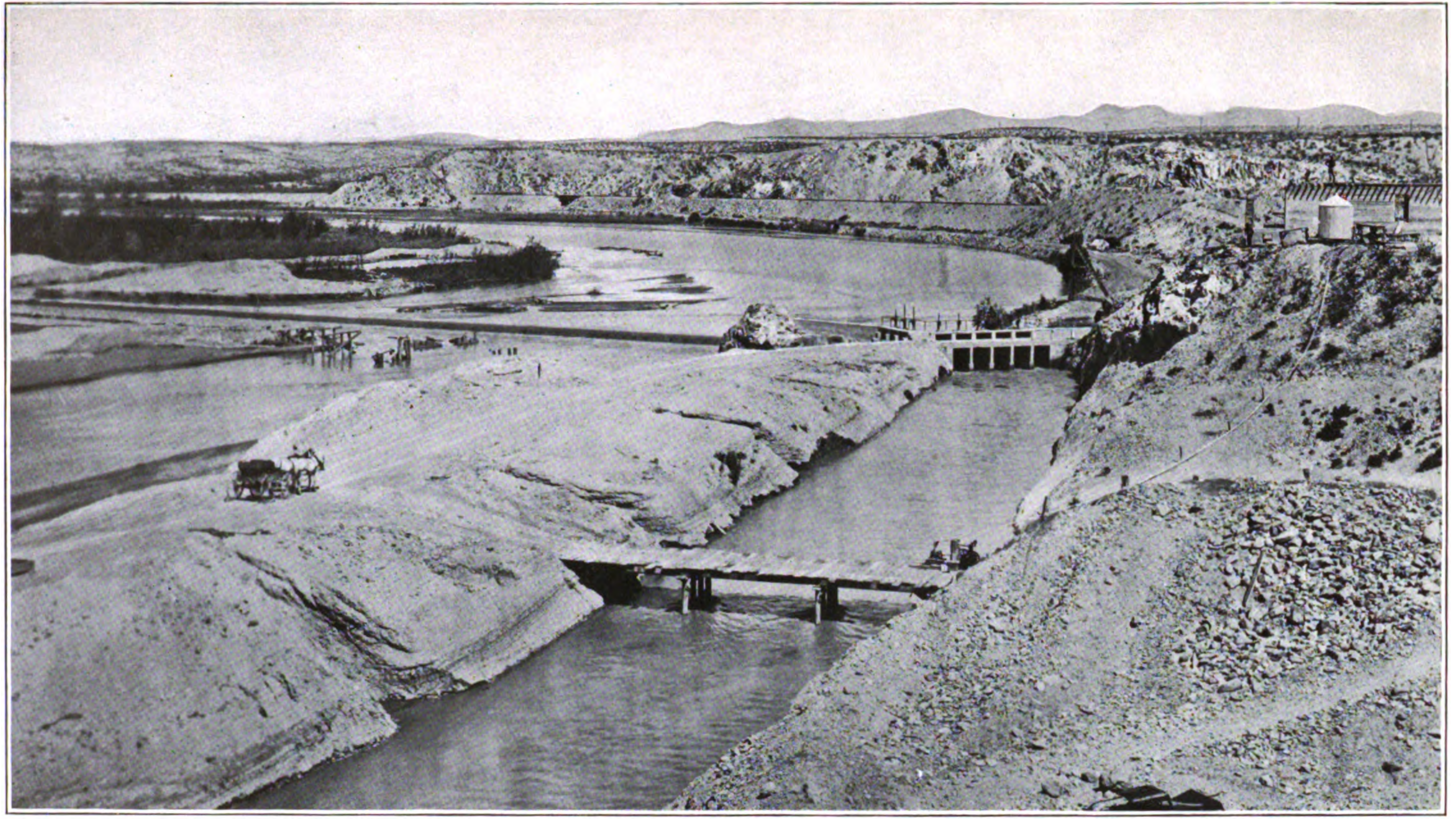
Many national forests have been established on the headwaters of the Rio Grande and its tributaries, both in Colorado and New Mexico. The drainage basin of the Rio Grande, exclusive of the Pecos, includes between 5,000 and 6,000 square miles of merchantable-timber land, 6,000 square miles of woodland and sparsely timbered land, and 2,000 square miles of burned and cut-over land, the remainder being sagebrush and open land.

The largest tributaries are the Conchos, which enters from the Mexico side, 200 miles below El Paso; the Conejos, which joins the Rio Grande just above the Colorado-New Mexico line; the Chama, which enters it in the Espanola Valley; the Pecos, which joins it in the southwestern part of Texas; and Devils River, about 50 miles below the Pecos. Most of the remaining tributaries are intermittent in character.

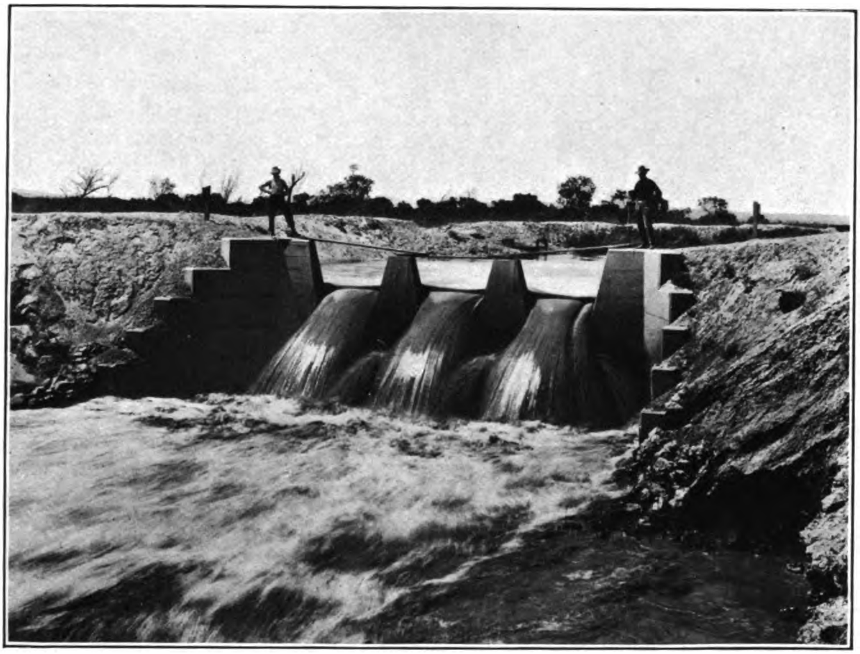
The mountains at the headwaters reach altitudes up to 14,000 feet above sea level. At Albuquerque, N. Mex., the elevation of the river is 5,000 feet and it leaves the Territory at an elevation of about 4,000 feet.

The rainfall varies greatly from year to year and from source to mouth, its irregularity making it very difficult to give averages. The annual precipitation in the mountainous district of Colorado—that is, along the upper Rio Grande—ranges from 15 to 25 inches. In the northern part of New Mexico it ranges from 10 to 15 inches and in the southern part from 5 to 12 inches.

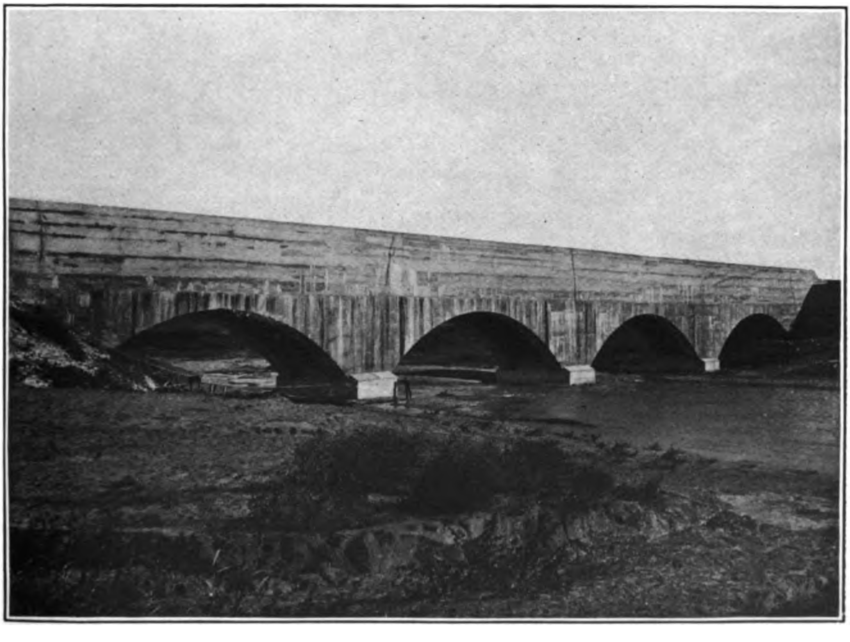
In the mountains of Colorado the river is covered with a foot or more of ice from early in the winter until late in the spring. During severe winters the river is frozen over at times in northern New Mexico,



LEASBURG DIVERSION DAM AND HEADGATES OF RIO GRANDE CANAL, RIO GRANDE PROJECT, NEW MEXICO, LOOKING UPSTREAM.



A. THE LARGEST CONCRETE DROP IN MAIN RIO GRANDE CANAL, RIO GRANDE PROJECT, NEW MEXICO.



B. CONCRETE FLUME ACROSS PECOS RIVER, CARLSBAD PROJECT, NEW MEXICO.

and the snowfall is often very heavy. From the melting of the snows in Colorado and New Mexico comes the spring floods.

Irrigation is now practiced extensively in the following valleys along the Rio Grande and its smaller tributaries:

1. *San Luis Valley,* beginning a short distance above Del Norte and extending to the mouth of Conejos River. This district contains probably the largest cultivated area along the Rio Grande, aggregating nearly half a million acres.
2. *Valleys of the Taos district,* lying on the east side of the river below the Colorado line and including the valleys of Red River, Arroyo Hondo, and Taos. The Taos Valley surpasses the others both in water facilities and in area cultivated.
3. *Espanola Valley,* located south of the Taos district and Tres Piedras Mesa. It lies along the river, and, as in the Taos country, agriculture has been engaged in for years.
4. *Albuquerque district,* including the valley from Pena Blanco to San Marcial. The system of irrigation is practically the same as the old Pueblo Indian system. In the last few years, however, new settlers have adopted progressive methods and have greatly increased the duty of water.
5. *Mesilla Valley,* next to San Luis, is the most important agricultural area along the Rio Grande. The valley broadens just below Selden and continues generally broad and fertile for a distance of 35 miles or beyond the Texas line. A view of the Leasburg diversion dam of the United States Reclamation Service's Rio Grande project is presented in Plate III. The main canal of the same project is shown in Plate IV, *A*.

Along the Rio Grande and its tributaries in Colorado and New Mexico are available reservoir sites equal to storing of all flood waters. The largest reservoir in the country is about to be built near Engle, N. Mex. It will impound 2,500,000 acre-feet of water for the irrigation of nearly 200,000 acres of land in New Mexico, Texas, and Mexico.

The estimated power available on the Rio Grande and its tributaries, from its source to El Paso, Tex., is theoretically as follows:

Minimum horsepower	123, 500
Minimum horsepower, six high months	241, 000
Horsepower from storage, six months period	405, 000

Developments will, however, be made chiefly on the upper tributaries in Colorado and a few of the mountain streams in New Mexico, and will not amount to more than 100,000 horsepower. At present very few water-power plants of any importance are operated in the drainage basin. The waters of the Rio Grande have been used only for irrigation and domestic purposes, but some of the tributaries have also been used in mining.

The wettest years on the upper Rio Grande appear to be 1906 and 1907; 1902 and 1908 are low-water years.

The determination of the amount of water in the Rio Grande is of importance, both on account of its use in irrigation and from its bearing upon interstate and international distribution of water. Most of the New Mexico and all of the Texas stations down to Eagle Pass are maintained by the United States section of the International Boundary Commission. The data used for the following stations have been collected by W. W. Follett, consulting engineer for the commission, and have been furnished through the courtesy of Gen. Anson Mills, commissioner:

Rio Grande near San Marcial, N. Mex.
Rio Grande near El Paso, Tex.
Rio Grande above Presidio, Tex.
Rio Grande below Presidio, Tex.
Rio Grande near Langtry, Tex.
Rio Grande at Eagle Pass, Tex.
Pecos River near Moorhead, Tex.
Devils River near Devils River Station, Tex.

On account of the shifting character of the river beds at the international water stations, no rating tables have been prepared. The estimated monthly discharges are from daily discharges computed by Mr. Follett directly from the discharge measurements.

The five stations from Laredo down (Laredo, Roma, Brownsville, Salado near Guerrero, and San Juan at Santa Rosalia ranch) are maintained by the Mexican section of the commission.

RIO GRANDE PROPER.

RIO GRANDE AT THIRTYMILE BRIDGE, NEAR CREEDE, COLO.

This station, which was established June 18, 1909, is about 30 miles west of Creede, Colo., and about 200 feet above the mouth of Big Squaw Creek at an elevation of about 9,200 feet above sea level.

No water is diverted above the station and none of any importance for many miles below except a little water used for meadow irrigation. The station is about one-half mile downstream from the proposed reservoir of the Farmers Union Irrigation Company, which will store flood water to be used in the irrigation of land in the valley 70 miles downstream. The records at this station have been taken at the expense of the company by their engineers under the general direction of the United States Geological Survey.

The chain gage, the datum of which has remained constant, is on the right bank 200 feet upstream from the Thirtymile Bridge, and discharge measurements have been made from a cable 30 yards below the gage.

This stream is frozen over for a number of months each year and there is also a large snowfall in that locality.

Discharge measurements of Rio Grande at Thirtymile Bridge, near Creede, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 19	Freeman and Pennock	60	255	5.90	1,440
June 21	O. P. Pennock	59	232	5.50	1,220
June 24	do	58	222	5.30	1,050
June 26	do	57	196	5.05	910
June 29	do	56	195	4.90	880
June 30	do	55	191	4.78	806
July 4	do	55	194	4.75	840
July 8	do	54	159	4.12	494
July 11	do	52	135	3.70	366
July 15	Pennock and Vandemoer	52	121	3.48	315
July 18	do	51	111	3.20	241
July 21	do	52	119	3.45	303
July 22	do	53	155	4.12	531
July 29	do	51	117	3.38	285
August 8 [a]	do	49	100	3.00	205
August 10	do	48	96	2.90	179
August 25	do	50	105	3.12	250

[a] Measurement not satisfactory, meter not working well.

Daily gage height, in feet, of Rio Grande at Thirtymile Bridge, near Creede, Colo., for 1909.

[O. P. Pennock, observer.]

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1		4.7	3.15	3.5	16		3.35	3.4	3.8
2		4.55	3.25	3.4	17		3.3	3.1	3.7
3		4.55	3.1	3.4	18	6.2	3.25	3.1	3.6
4		4.7	3.2	3.6	19	5.9	3.2	3.2	3.5
5		4.85	3.1	6.15	20	5.65	3.2	3.6	3.45
6		4.6	3.2	5.75	21	5.5	3.55	3.4	3.35
7		4.4	3.05	5.2	22		4.3	3.3	3.25
8		4.15	3.0	4.8	23		3.6	3.35	3.2
9		4.1	3.0	4.5	24	5.3	3.85	3.25	3.15
10		3.85	2.9	4.3	25	5.15	3.55	3.15	3.1
11		3.8	3.2	4.2	26	5.05	3.8	3.15	3.05
12		3.7	3.25	4.4	27	4.9	3.9	3.3	3.0
13		3.6	3.15	4.2	28	4.9	3.55	3.2	2.9
14		3.5	3.1	4.05	29	5.0	3.4	3.6	2.85
15		3.45	3.05	3.9	30	4.8	3.3	3.5	2.85
					31		3.2	3.5	

Daily discharge, in second-feet, of Rio Grande at Thirtymile Bridge, near Creede, Colo., for 1909.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1		788	230	316	16		276	289	409
2		717	252	289	17		264	220	376
3		717	220	289	18	1,640	252	220	345
4		788	241	345	19	1,450	241	241	316
5		861	220	1,610	20	1,300	241	345	302
6		740	241	1,360	21	1,210	330	289	276
7		648	210	1,040	22	[a] 1,170	604	264	252
8		540	201	836	23	[a] 1,130	345	276	241
9		520	201	694	24	1,100	426	252	230
10		426	184	604	25	1,010	330	230	220
11		409	241	561	26	962	409	230	210
12		376	252	648	27	886	444	264	201
13		345	230	561	28	886	330	241	184
14		316	220	500	29	936	289	345	176
15		302	210	444	30	836	264	316	176
					31		241	316	

[a] Interpolated.

NOTE.—These discharges are based on a rating curve that is well defined between 169 and 1,510 second-feet.

Monthly discharge of Rio Grande River at Thirtymile Bridge, near Creede, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
June (18-30)	1,640	836	1,120	28,900	A.
July	861	241	444	27,300	A.
August	345	184	248	15,200	A.
September	1,610	176	467	27,800	A.

RIO GRANDE NEAR CREEDE, COLO.

The station, which was established April 24, 1907, to obtain information concerning the quantity of run-off of the upper Rio Grande available for storage, is located at the three-span highway bridge one-quarter mile south of Wason siding, on the Creede branch of the Denver & Rio Grande Railroad, about 3 miles from Creede, the terminus of the line, and is a few miles above the site of a proposed dam and reservoir. The chain gage is fastened to the downstream side of left span, and discharge measurements are also made from the same side.

Willow Creek (or Goblin Creek) enters the river a short distance upstream from Wason, and Goose Creek comes in at Wagon-wheel Gap, about 5 miles below. The drainage area above the station is about 700 square miles.

Except for a little meadow irrigation, no water is diverted above this station. Two or three reservoirs are about to be constructed on the upper waters of the Rio Grande and its tributaries above Wason. Among others may be mentioned the Farmers' Union Irrigation Co.'s reservoir on the main stream, about 35 miles above. The proposed reservoir near Wason will have a capacity almost equal to the normal annual flow of the river.

The winters are long and very severe in this locality, and the stream has a heavy ice cover for several months. The bridge piers cause eddies, which materially affect the accuracy of measurements. The river channel is rough and the velocity high at flood stages, so that results obtained at this station are only fair.

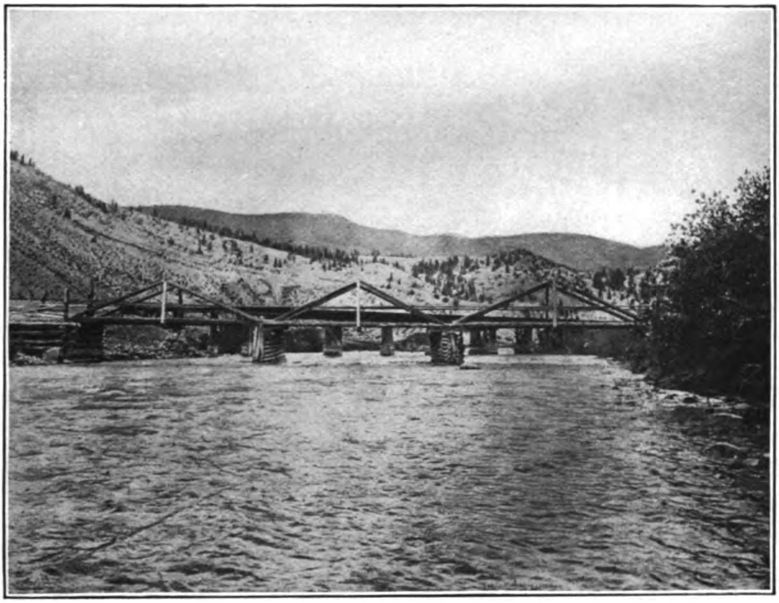
The datum of the gage has not been changed since the station was established.

A view of the river at this station is shown in Plate V, *A*.

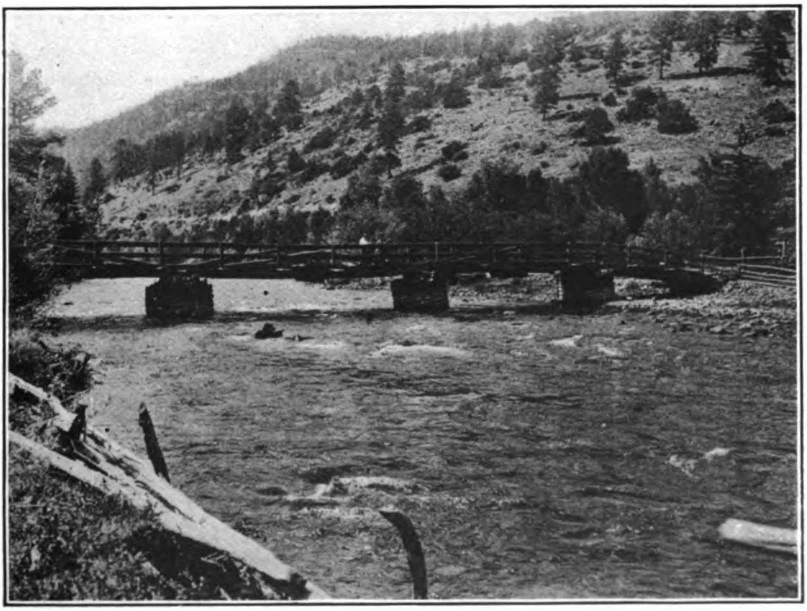
Discharge measurements of Rio Grande near Creede, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 18	W. B. Freeman	116	485	3.39	2,800
June 17	.....do	116	547	3.90	3,260
June 20	.....do	116	537	4.13	3,400
Aug. 5	G. H. Russell	107	238	1.22	588
Oct. 6	.....do	105	243	1.05	546
Dec. 10 [a]	.....do	65	146	.88	233

[a] Made by wading; ice along edges.



A. RIO GRANDE NEAR CREEDE, COLO.



B. CONEJOS RIVER NEAR MOGOTE, COLO.

Daily gage height, in feet, of Rio Grande near Creede, Colo., for 1909.

[Henry H. Wason, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	1.45	2.45	2.7	1.15	1.35	0.95	0.85
2	0.25	1.65	3.0	2.6	1.35	1.35	.95	.85
3	.25	1.7	4.15	2.65	1.25	1.5	.95	.85
4	.25	1.95	5.15	2.55	1.25	1.65	1.0	.9
5	.25	2.5	5.65	2.95	1.25	2.85	1.05	.85
6	.35	2.85	5.75	2.75	1.25	3.95	1.05	.8
7	.35	3.05	4.95	2.45	1.2	3.65	1.0	.85
8	.35	3.15	4.95	2.2	1.15	3.7	1.0	.85
9	.55	3.0	4.8	2.05	1.15	3.7	1.0	.8
10	.55	2.95	4.6	1.95	1.35	3.05	1.0	.8
11	.55	2.95	4.5	1.85	1.25	2.75	1.0	.8
12	.55	2.75	4.5	1.65	1.25	2.6	.95	.75
13	.55	3.0	4.5	1.65	1.25	2.25	.95	.75
14	.7	3.0	4.0	1.5	1.2	2.25	.9	.7
15	.75	3.1	4.3	1.45	1.25	2.05	.95	.6
16	.75	3.15	4.45	1.35	1.3	1.9	.95	.6
17	.75	3.3	4.25	1.25	1.2	1.8	.95	.55
18	.75	3.55	4.35	1.25	1.2	1.65	.95	.5
19	2.35	3.55	4.2	1.25	1.25	1.55	.9	.5
20	2.15	3.6	4.15	1.25	1.35	1.55	.9	.5
21	1.7	3.65	3.95	1.85	1.4	1.45	.9	.4
22	1.4	3.15	3.7	2.35	1.25	1.35	.9	.4
23	1.5	2.85	3.65	2.4	1.35	1.35	.9	.4
24	1.5	2.7	3.4	2.25	1.35	1.35	.9	.3
25	....	2.9	3.25	1.7	1.25	1.25	.9	.3
26	....	2.85	3.25	1.7	1.15	1.15	.9	.3
27	1.45	3.35	....	1.75	1.15	1.05	.9	....
28	1.75	3.6	2.85	1.65	1.45	1.05	.9	.2
29	1.65	3.45	2.85	1.45	1.45	1.05	.85	.2
30	1.45	2.9	2.75	1.35	1.45	1.05	.8	....
31	....	....	....	1.25	1.35	....	....	....

Note.—Ice conditions during December.

Daily discharge, in second-feet, of Rio Grande near Creede, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	[a] 161	742	1,610	1,880	555	678	442	390
2	161	882	2,240	1,770	678	678	442	390
3	161	920	3,770	1,820	615	775	442	390
4	161	1,120	5,290	1,720	615	882	470	415
5	161	1,660	6,090	2,180	615	2,060	498	390
6	190	2,060	6,250	1,940	615	3,490	498	365
7	190	2,300	4,970	1,610	585	3,080	470	390
8	190	2,420	4,970	1,350	555	3,150	470	390
9	260	2,240	4,740	1,210	555	3,150	470	365
10	260	2,180	4,430	1,120	678	2,300	470	365
11	260	2,180	4,280	1,040	615	1,940	470	365
12	260	1,940	4,280	882	615	1,770	442	342
13	260	2,240	4,280	882	615	1,400	442	342
14	320	2,240	3,560	775	585	1,400	415	320
15	342	2,360	3,980	742	615	1,210	442	280
16	342	2,420	4,200	678	645	1,080	442	280
17	342	2,620	3,910	615	585	1,000	442	260
18	342	2,950	4,060	615	585	882	442	240
19	1,500	2,950	3,840	615	615	810	415	240
20	1,300	3,020	3,770	615	678	810	415	240
21	920	3,080	3,490	1,040	710	742	415	205
22	710	2,420	3,150	1,500	615	678	415	205
23	775	2,060	3,080	1,560	678	678	415	205
24	775	1,880	2,740	1,400	678	678	415	175
25	[a] 764	2,120	2,550	920	615	615	415	175
26	[a] 753	2,060	2,550	920	555	555	415	175
27	742	2,680	[a] 2,300	960	555	498	415	[a] 161
28	960	3,020	2,060	882	742	498	415	147
29	882	2,810	2,060	742	742	498	390	147
30	742	2,120	1,940	678	742	498	365	[a] 147
31	....	[a] 1,860	....	615	678	....	[a] 378	....

[a] Interpolated.

Note.—These discharges are based on a rating curve that is well defined below 2,880 second-feet.

Monthly discharge of Rio Grande near Creede, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April	1,500	161	506	30,100	A.
May	3,080	742	2,180	134,000	A.
June	6,250	1,610	3,680	219,000	B.
July	2,180	615	1,140	70,100	A.
August	742	555	630	38,700	A.
September	3,490	498	1,280	76,200	A.
October	498	365	435	26,700	A.
November	415	147	283	16,800	A.
The period				612,000	

RIO GRANDE NEAR DEL NORTE, COLO.

This station, which was established in the fall of 1889, was originally located about 2 miles above Del Norte, and records were taken more or less continuously until May 16, 1908, when a new station was established at the new state highway bridge about 6 miles above Del Norte, near the upper edge of the San Luis Valley. Some inflow takes place between the two points at certain seasons of the year, so that the mean annual flow at the state bridge is somewhat less than that at the old station.

As the station is above all the important diversions, the records show the amount of water available for irrigation and also the run-off from a drainage area of 1,400 square miles.

The new station is about 4 miles above the mouth of Los Pinos Creek, below the mouth of Wolf Creek, and about 10 miles below the mouth of the South Fork of the Rio Grande. The old station is just above the mouth of Los Pinos Creek.

The diversions from the Rio Grande and its tributaries above this point are all small and are used chiefly for meadow irrigation. They represent a very small percentage of the total flow of the stream. The largest ditch takes water out at Del Norte, about 2 miles below the original station. From this canal and many others diverted at various points nearly 300,000 acres of land in Colorado are now being irrigated from the Rio Grande.

Numerous small storage reservoirs under construction or in contemplation on the tributaries of the Rio Grande will store a large proportion of flood waters, but all the waters of the upper Rio Grande have been filed upon.

The flow of the stream is affected by ice for three or four months during the winter.

Practically no change was made in the datum of the gage at the old station during its maintenance, and this old gage is still being used by the water commissioner in that irrigation district of the State. The present chain gage is located on the highway bridge, and the readings have no determined relation to those taken at the old gage. Discharge measurements are made from the downstream side of the bridge.

Very good results can be obtained at the present station except when ice conditions prevail.

Discharge measurements of Rio Grande near Del Norte, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 17	W. B. Freeman	181	733	3.58	3,730
June 21	do	193	878	4.27	4,960
Aug. 4	G. H. Russell	166	393	1.60	840
Oct. 1	do	167	383	1.40	752

Daily gage height, in feet, of Rio Grande near Del Norte, Colo., for 1909.

[James G. Duncan, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.8	2.85	3.05	1.55	1.85	1.4	1.0	0.95
2		1.9	3.2	2.95	1.5	1.75	1.35	1.05	1.0
3		2.25	3.85	2.95	1.55	1.75	1.35	1.1	1.0
4		2.65	4.4	2.9	1.55	1.85	1.35	1.05	1.0
5		3.2	4.9	2.9	1.6	2.2	1.65	1.0	1.0
6		3.5	5.15	3.15	1.5	4.3	1.7	1.0	.95
7		3.65	5.0	2.9	1.5	4.25	1.7	1.0	.95
8		4.0	4.9	2.6	1.4	3.45	1.65	1.0	1.0
9		3.35	4.8	2.45	1.4	3.0	1.5	1.0	1.0
10		3.3	4.7	2.3	1.35	2.75	1.5	1.05	1.05
11		3.4	4.6	2.15	1.45	2.6	1.45	1.0	1.05
12		3.35	4.4	2.05	1.4	2.45	1.45	.95	.95
13		3.4	4.5	1.9	1.5	2.65	1.4	.95	1.0
14		3.4	4.2	1.85	1.5	2.55	1.4	.9	1.0
15		3.15	4.2	1.8	1.45	2.45	1.35	.9	1.0
16		3.35	4.3	1.75	1.5	2.3	1.3	.8	.95
17		3.55	4.25	1.7	1.5	2.2	1.3	.75	1.05
18		3.95	4.3	1.65	1.45	2.1	1.3	.75	1.05
19		4.05	4.25	1.6	1.45	2.0	1.25	.85	
20		3.9	4.35	1.6	1.65	1.95	1.25	1.0	
21		3.55	4.25	1.6	1.75	1.85	1.25	1.1	
22		3.45	4.05	1.7	1.55	1.8	1.2	1.0	
23		3.35	4.0	2.1	1.65	1.75	1.2	1.0	
24		3.25	3.95	2.25	1.65	1.65	1.15	1.1	
25	1.7	3.1	3.8	2.05	1.8	1.6	1.15	1.1	
26	1.8	3.15	3.8	1.85	1.6	1.6	1.15	1.0	
27	2.1	3.55	3.5	2.1	1.65	1.55	1.1	1.0	
28	2.3	3.85	3.35	1.95	1.65	1.5	1.1	1.05	
29	2.25	3.4	3.2	1.75	2.05	1.45	1.1	1.0	
30	2.0	3.1	3.3	1.65	1.95	1.4	1.1	1.0	
31		3.05		1.6	1.9		1.05		

NOTE.—Probable ice conditions December 19–31.

Daily discharge, in second-feet, of Rio Grande near Del Norte, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	1,060	2,420	2,720	832	1,110	710	425	398
2	....	1,160	2,970	2,560	790	1,020	672	458	425
3	....	1,560	4,140	2,560	832	1,020	672	490	425
4	....	2,120	5,260	2,490	832	1,110	672	458	425
5	....	2,970	6,320	2,490	875	1,490	920	425	425
6	....	3,500	6,870	2,880	790	5,050	965	425	398
7	....	3,770	6,540	2,490	790	4,940	965	425	398
8	....	4,430	6,320	2,040	710	3,410	920	425	425
9	....	3,230	6,100	1,830	710	2,640	790	425	425
10	....	3,140	5,890	1,620	672	2,260	790	458	458
11	....	3,320	5,680	1,430	750	2,040	750	425	458
12	....	3,230	5,260	1,320	710	1,830	750	398	398
13	....	3,320	5,470	1,160	790	2,120	710	398	425
14	....	3,320	4,840	1,110	790	1,970	710	370	425
15	....	2,880	4,840	1,060	750	1,830	672	370	425
16	....	3,230	5,050	1,020	790	1,620	635	320	398
17	....	3,590	4,940	965	790	1,490	635	295	458
18	....	4,340	5,050	920	750	1,370	635	295	458
19	....	4,530	4,940	875	750	1,260	598	345	400
20	....	4,240	5,160	875	920	1,210	598	425	400
21	....	3,590	4,940	875	1,020	1,110	598	490	350
22	....	3,410	4,530	965	832	1,060	560	425	350
23	....	3,230	4,430	1,370	920	1,020	560	425	350
24	....	3,060	4,340	1,560	920	920	525	490	350
25	965	2,800	4,050	1,320	1,060	875	525	490	350
26	1,060	2,880	4,050	1,110	875	875	525	425	350
27	1,370	3,590	3,500	1,370	920	832	490	425	350
28	1,620	4,140	3,230	1,210	920	790	490	458	350
29	1,560	3,320	2,970	1,020	1,320	750	490	425	350
30	1,260	2,800	3,140	920	1,210	710	490	425	350
31	....	2,720	....	875	1,160	....	458	....	350

NOTE.—These discharges are based on a rating curve that is fairly well defined. Discharges December 19-31 estimated because of probable ice conditions.

Monthly discharge of Rio Grande near Del Norte, Colo., for 1909.

[Drainage area, 1,400 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
April 25-30	1,620	965	1,310	.936	0.21	15,600	A.
May	4,530	1,060	3,180	2.27	2.62	196,000	A.
June	6,870	2,420	4,770	3.41	3.80	284,000	A.
July	2,880	875	1,520	1.09	1.26	93,500	A.
August	1,320	672	864	.617	0.71	53,100	A.
September	5,050	710	1,660	1.19	1.33	98,800	A.
October	965	458	661	.472	.54	40,600	B.
November	490	295	418	.299	.33	24,900	B.
December	458	350	397	.284	.33	24,400	C.
The period						831,000	

RIO GRANDE NEAR LOBATOS, COLO.

This station was established June 28, 1899, at the state bridge about 15 miles east of Antonito, in T. 33 N., R. 11 E.

The station is particularly important because it is located only a few miles above the Colorado-New Mexico line, and the records show the amount of water passing from Colorado into New Mexico. The data are valuable also in connection with the proposed Engle reservoir of the United States Reclamation Service, and they will be used in the adjudication of all water rights along the Rio Grande which must eventually be made.

Conejos River enters about 7 miles above the station. A large part of the normal flow of the river is diverted above this station during the irrigation period. About 450,000 acres of land are irrigated, and more will be put under water in connection with some of the proposed reservoir systems above.

Ice usually forms on the river at this point for about three months during the winter, but occasionally open-water conditions prevail through part of this period.

The datum of the gage has not been changed since the station was established. The present chain gage is fastened to downstream handrail of bridge. Measurements are also made from downstream side of this bridge. Very good results have been obtained at this station. The river channel is quite permanent, being a gash cut in the lava rock. Occasionally during low water some sediment is deposited, but it is scoured out in times of flood.

Discharge measurements of Rio Grande near Lobatos, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 13[a]	J. B. Stewart	192	150	2.20	390
Mar. 26	do	224	402	1.90	480
May 16	Freeman and Stewart	251	990	4.60	3,960
June 22	W. B. Freeman	255	1,180	5.01	4,310
Aug. 2	G. H. Russell	196	256	1.40	170
Sept. 29	do	233	572	2.62	1,140
Nov. 12	J. B. Stewart	222	426	2.05	500
Dec. 19[1]	G. H. Russell	130	258	2.28	280

[a] Ice conditions.

Daily gage height, in feet, of Rio Grande near Lobatos, Colo., for 1909.

[Roman Mondragon, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.3	1.85	1.95	1.9	2.9	3.65	3.1	1.4	3.1	2.5	1.9	2.15
2	2.3	1.85	1.65	1.9	2.65	3.4	2.95	1.3	3.05	2.5	1.9	2.2
3	2.3	1.85	1.75	1.9	2.65	3.4	2.75	1.3	3.1	2.45	2.0	2.1
4	2.3	1.85	1.9	1.9	2.95	3.65	2.6	1.3	3.0	2.35	2.0	2.1
5	2.3	1.9	1.95	1.9	3.35	4.15	2.6	1.2	3.1	2.3	2.0	2.4
6	2.3	1.95	1.95	1.9	4.0	5.4	2.7	1.2	3.6	2.4	2.0	2.3
7	2.3	1.95	1.95	1.9	4.6	5.95	2.7	1.15	4.35	2.55	2.0	2.35
8	2.3	2.0	1.95	1.9	5.05	6.4	2.8	1.2	4.8	2.8	2.0	2.35
9	2.3	2.05	1.95	1.9	5.15	6.65	2.6	1.25	4.9	2.8	2.0	2.4
10	2.3	2.05	2.05	1.9	5.2	6.7	2.4	1.3	5.0	2.8	2.0	2.4
11	2.3	2.05	1.95	1.9	5.05	6.55	2.3	1.4	4.7	2.7	2.0	2.4
12	2.3	2.05	2.1	1.9	4.95	6.35	2.1	1.45	4.35	2.55	2.0	2.3
13	2.3	2.2	2.05	1.85	4.85	6.1	1.9	1.4	4.1	2.55	2.1	2.3
14	2.3	2.15	1.85	1.85	4.75	5.85	1.8	1.4	4.1	2.55	2.1	2.3
15	2.35	2.15	1.95	2.2	4.85	5.65	1.6	1.4	3.95	2.5	2.1	2.4

Daily gage height, in feet, of Rio Grande near Lobatos, Colo., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	2.35	2.15	2.05	2.2	4.8	5.35	1.5	1.4	3.9	2.4	2.1	2.3
17	2.35	2.05	2.05	2.2	4.4	4.9	1.4	1.4	3.75	2.4	2.0	2.15
18	2.35	1.95	1.95	2.45	4.5	5.0	1.3	1.6	3.6	2.35	1.95	2.3
19	2.35	1.95	1.95	3.4	4.85	5.1	1.3	1.7	3.5	2.25	1.9	2.3
20	2.3	1.95	1.95	4.0	5.0	5.2	1.3	1.8	3.4	2.25	1.85	2.1
21	2.3	1.95	1.95	4.05	5.1	5.15	1.1	1.9	3.25	2.2	1.95	2.3
22	2.3	2.05	1.95	3.65	5.0	5.0	1.1	1.9	3.15	2.2	2.1	2.15
23	2.25	2.05	1.95	3.35	4.55	4.85	1.1	2.5	3.0	2.2	2.1	2.35
24	2.2	2.05	1.95	3.0	4.3	4.55	1.1	2.2	2.85	2.15	2.2	2.15
25	2.1	2.05	1.95	2.8	3.95	4.35	1.15	2.25	2.85	2.1	2.2	2.05
26	2.0	2.05	1.95	2.7	3.7	4.2	1.8	2.4	2.8	2.1	2.2	2.3
27	2.0	2.05	1.95	2.6	3.65	4.0	2.0	2.4	2.7	2.1	2.2	2.2
28	1.9	2.05	1.95	2.65	3.85	3.85	1.75	2.5	2.7	2.1	2.1	2.3
29	1.85	....	1.95	2.85	4.1	3.65	1.6	2.65	2.65	2.0	2.1	2.2
30	1.85	....	1.95	3.15	4.1	3.45	1.6	2.9	2.6	1.95	2.2	2.2
31	1.85	....	1.9	....	3.75	....	1.5	3.0	....	1.95	....	2.2

NOTE.—Probable ice conditions January 1 to March 1 and December 5–31.

Daily discharge, in second-feet, of Rio Grande near Lobatos, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	400	410	350	460	1,470	2,480	1,730	205	1,730	1,000	460	660
2	400	410	320	460	1,170	2,130	1,540	165	1,660	1,000	460	705
3	400	410	372	460	1,170	2,130	1,290	165	1,730	950	530	615
4	400	420	460	460	1,540	2,480	1,110	165	1,600	850	530	615
5	400	420	495	460	2,060	3,220	1,110	135	1,730	800	530	600
6	400	440	495	460	2,990	5.200	1,230	135	2,410	900	530	600
7	400	440	495	460	3,920	6,120	1,230	122	3,530	1,060	530	600
8	400	440	495	460	4,630	6.920	1,350	135	4,230	1,350	530	570
9	400	450	495	460	4.790	7,370	1,110	150	4,390	1,350	530	570
10	400	430	572	460	4,870	7,460	900	165	4,550	1,350	530	570
11	400	430	495	460	4,630	7,190	800	205	4,070	1,230	530	550
12	400	400	615	460	4,470	6,830	615	228	3,530	1,060	530	550
13	400	390	572	430	4,310	6,380	460	205	3,140	1,060	615	500
14	400	380	430	430	4,150	5,940	400	205	3,140	1,060	615	500
15	400	380	495	705	4,310	5,610	295	205	2,920	1,000	615	450
16	400	380	572	705	4,230	5,110	250	205	2,840	900	615	450
17	400	370	572	705	3.600	4.390	205	205	2,630	900	530	400
18	400	370	495	950	3,760	4,550	165	295	2,410	850	495	300
19	400	370	495	2,130	4,310	4,710	165	345	2,270	752	460	280
20	400	370	495	2,990	4,550	4,870	165	400	2,130	752	430	300
21	400	380	495	3,060	4,710	4,790	110	460	1,920	705	495	300
22	400	380	495	2,480	4,550	4,550	110	460	1,800	705	615	300
23	400	380	495	2,060	3.840	4,310	110	1,000	1,600	705	615	300
24	400	380	495	1,600	3.450	3,840	110	705	1,410	660	705	300
25	400	380	495	1,350	2,920	3,530	122	752	1,410	615	705	300
26	400	380	495	1,230	2,560	3,300	400	900	1,350	615	705	300
27	400	380	495	1,110	2,480	2,990	530	900	1,230	615	705	300
28	400	380	495	1,170	2,770	2,770	372	1,000	1,230	615	615	300
29	400	....	495	1,410	3,140	2,480	295	1,170	1.170	530	615	300
30	400	....	495	1,800	3,140	2,200	295	1,470	1,110	495	705	300
31	400	....	460	....	2,630	....	250	1,600	....	495	....	300

NOTE.—These discharges are based on a rating curve that is well defined below 4,550 second-feet. Discharges estimated January 1 to March 1 and December 5–31, due to probable ice conditions.

Monthly discharge of Rio Grande near Lobatos, Colo., for 1909.

[Drainage area, 7,700 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	400	400	400	0.052	0.06	24,600	C.
February	450	370	398	.052	.05	22,100	C.
March	615	320	490	.064	.07	30,100	A.
April	3,060	430	1,060	.138	.15	63,100	A.
May	4,870	1.170	3,460	.449	.52	213,000	A.
June	7,460	2,130	4,520	.587	.65	269,000	A.
July	1,730	110	607	.079	.09	37,300	A.
August	1,600	122	466	.061	.07	28,700	A.
September	4,550	1,110	2,360	.306	.34	140,000	A.
October	1,350	495	869	.113	.13	53,400	A.
November	705	430	569	.074	.08	33,900	A.
December	705	300	441	.057	.07	27,100	C.
The year	7,460	110	1,300	.169	2.28	942,000	

RIO GRANDE NEAR BUCKMAN,[1] N. MEX.

This station was first established February 1, 1895, to obtain data for use in connection with irrigation enterprises. Since that date records have been obtained at various intervals. It is located at the Denver & Rio Grande Railroad bridge, which crosses the river one-eighth mile east of Rio Grande. The bridge is about 9 miles below Espanola, 2 miles below San Ildefonso, an Indian pueblo 3½ miles above Buckman lumber camp. No important tributaries enter in the immediate vicinity.

Beginning in the vicinity of Del Norte, Colo., many large and small ditches divert water for irrigation.

The original gage was located on the left bank, about 200 feet above the bridge, and measurements were made from a cable which was located just above the bridge. On March 30, 1904, a vertical rod gage was established at a new datum on the downstream side of the railroad pier. The station was discontinued December 31, 1905, and reestablished June 22, 1909, the same gage being used as in 1904. The cable had been removed, and measurements during 1909 were made from the bridge. Gage heights are not affected by ice. Since 1904 the datum has remained practically unchanged.

Discharge measurements of Rio Grande near Buckman, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 22	J. B. Stewart	158	1,160	5.75	6,860
Aug. 2	do	103	253	2.15	603
Aug. 27	do		462	3.70	2,040

NOTE.—These measurements are liable to be considerably in error because of the skew of the bridge and cross currents.

---

[1] Formerly known as near San Ildefonso.

Daily gage height, in feet, of Rio Grande near Buckman, N. Mex., for 1909.

[Aaron Martinez, observer.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	4.7	2.2	4.0	3.35	2.3	2.05
2	....	4.35	2.0	4.2	3.0	2.2	2.25
3	....	4.2	2.2	4.1	2.9	2.25	2.25
4	....	4.2	2.35	4.0	2.9	2.25	2.35
5	....	4.0	2.75	4.75	2.8	2.1	2.5
6	....	4.35	2.85	6.0	2.85	2.2	2.45
7	....	4.1	2.40	5.85	3.55	2.1	2.35
8	....	3.95	2.25	5.95	3.75	2.05	2.25
9	....	4.05	2.1	6.15	3.25	2.0	2.15
10	....	3.9	2.0	6.1	3.45	1.9	1.95
11	....	3.5	2.05	6.3	3.65	1.8	2.0
12	....	3.35	2.3	5.95	3.65	1.85	1.85
13	....	3.25	2.4	5.75	3.50	1.75	2.05
14	....	3.15	2.4	5.55	3.45	1.8	2.1
15	....	3.0	2.5	5.35	3.35	1.7	2.0
16	....	3.3	2.5	5.25	3.25	1.75	1.95
17	....	3.1	2.6	5.15	3.25	1.75	1.85
18	....	2.8	3.2	4.95	3.2	1.85	1.9
19	....	2.6	3.75	4.75	2.95	1.8	1.95
20	....	2.15	3.95	4.55	2.85	1.7	1.95
21	....	2.05	5.8	4.45	2.8	1.75	2.05
22	....	2.2	3.85	4.3	2.7	1.7	2.15
23	6.65	2.4	3.55	4.2	2.65	1.75	2.25
24	6.4	2.25	3.8	3.95	2.6	2.05	2.15
25	5.95	2.5	3.7	3.85	2.5	2.05	2.05
26	5.8	2.7	3.95	3.65	2.45	2.05	2.25
27	5.65	2.6	3.85	3.50	2.4	2.2	2.15
28	5.4	2.4	3.75	3.40	2.5	2.05	2.05
29	5.15	2.5	3.85	3.5	2.3	2.2	2.15
30	4.85	2.25	3.75	3.45	2.3	2.05	2.05
31	....	2.15	4.15	....	2.3	....	1.95

Daily discharge, in second-feet, of Rio Grande near Buckman, N. Mex., for 1909.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	3,210	636	2,370	1,670	709	533
2	....	2,780	500	2,600	1,320	636	672
3	....	2,600	636	2,480	1,220	672	672
4	....	2,600	747	2,370	1,220	672	747
5	....	2,370	1,080	3,280	1,130	566	865
6	....	2,780	1,180	5,140	1,180	636	825
7	....	2,480	785	4,880	1,880	566	747
8	....	2,320	672	5,060	2,100	533	672
9	....	2,420	566	5,400	1,570	500	601
10	....	2,260	500	5,310	1,780	440	470
11	....	1,830	533	5,670	1,990	386	500
12	....	1,670	709	5,060	1,990	413	413
13	....	1,570	785	4,720	1,830	362	533
14	....	1,470	785	4,400	1,780	386	566
15	....	1,320	865	4,100	1,670	337	500
16	....	1,620	865	3,950	1,570	362	470
17	....	1,420	950	3,810	1,570	362	413
18	....	1,130	1,520	3,540	1,520	413	440
19	....	950	2,100	3,280	1,270	386	470
20	....	601	2,320	3,020	1,180	337	470
21	....	533	4,800	2,900	1,130	362	533
22	....	636	2,210	2,720	1,040	337	601
23	6,330	785	1,880	2,600	994	362	672
24	5,850	672	2,150	2,320	950	533	601
25	5,060	865	2,040	2,210	865	533	533
26	4,800	1,040	2,320	1,990	825	533	672
27	4,560	950	2,210	1,830	785	636	601
28	4,170	785	2,100	1,720	865	533	533
29	3,810	865	2,210	1,830	709	636	601
30	3,400	672	2,100	1,780	709	533	533
31	....	601	2,540	....	709	....	470

NOTE.—These discharges are based on a rating curve that is fairly well defined between 100 and 4,500 second-feet.

Monthly discharge of Rio Grande near Buckman, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
June 23-30	6,330	3,400	4,750	75,400	B.
July	3,210	533	1,540	94,700	B.
August	4,800	500	1,460	89,800	B.
September	5,670	1,720	3,410	203,000	B.
October	2,100	709	1,320	81,200	B.
November	709	337	489	29,100	B.
December	865	413	578	35,500	B.
The period				609,000	

RIO GRANDE NEAR SAN MARCIAL, N. MEX.

On August 8, 1889, a station was established near San Marcial and a measurement made giving a discharge of 19 second-feet. Soon after this date the gage was destroyed and the station abandoned until January 29, 1895, when it was reestablished at the Atchison, Topeka & Santa Fe Railway bridge, which crosses the river 1 mile south of San Marcial, N. Mex. The inclined gage, installed in 1895, was carried away in 1896 and a wire gage put in its place at the same datum. This was soon abandoned and gage heights were obtained by measuring, by means of a graduated rod, the distance from the bridge deck to the water surface.

Since January 1, 1901, the station has been maintained by the United States section of the International Boundary Commission.

The channel is sandy and very shifting. During high stages bridge piers interfere with the accuracy of results.

No important tributaries enter in the immediate vicinity.

Discharge measurements of Rio Grande near San Marcial, N. Mex., in 1909.

[By Geo. W. King.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	181	10.5	564	Mar. 12	209	10.6	1,037
5	150	10.4	649	15	216	10.5	836
8	176	10.4	581	18	158	10.4	643
11	179	10.4	634	21	149	10.4	698
14	178	10.4	736	24	166	10.2	708
17	163	10.5	723	27	191	10.4	913
20	195	10.4	747	30	224	10.6	1,082
23	198	10.5	774	Apr. 2	151	10.5	752
26	155	10.5	686	6	193	10.6	854
29	136	10.3	634	9	241	10.6	1,127
31	158	10.5	753	12	230	10.4	847
Feb. 3	147	10.4	591	15	237	10.6	867
6	147	10.5	697	18	392	11.0	1,141
9	152	10.5	666	21	716	11.9	4,074
12	161	10.5	688	24	659	12.0	3,696
15	152	10.3	549	27	563	11.3	2,904
18	150	10.5	631	30	480	11.25	2,737
22	190	10.6	657	May 3	508	11.5	3,135
25	172	10.6	615	6	525	11.1	2,834
28	144	10.4	529	9	1,058	12.5	6,340
Mar. 3	126	10.5	495	12	1,360	12.2	6,976
6	259	10.8	1,205	15	1,266	12.4	7,242
9	200	10.6	942	18	1,082	12.1	6,503

Discharge measurements of Rio Grande near San Marcial, N. Mex., in 1909—Continued.

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 21	1,093	12.2	6,622	Sept. 2	295	10.3	1,086
24	1,090	12.3	6,751	5	343	10.6	1,457
27	912	11.7	5,027	6	401	11.3	2,488
30	714	11.4	3,928	9	814	11.6	4,225
June 2	711	11.5	4,139	12	669	12.0	4,199
5	664	11.3	3,175	15	524	11.4	3,316
8	860	12.1	4,937	18	564	11.4	3,001
11	1,353	12.7	7,887	21	545	11.2	2,876
14	1,200	12.5	7,585	24	431	10.8	1,832
17	980	12.0	5,874	27	387	10.7	1,614
20	800	11.7	4,497	30	345	10.6	1,176
23	830	11.8	4,346	Oct. 3	271	10.5	914
26	788	11.5	4,121	7	198	10.4	764
29	664	11.1	3,156	10	507	11.1	2,029
July 2	602	10.9	2,010	13	251	10.8	1,317
5	391	10.5	1,398	16	431	10.7	1,280
8	370	10.2	1,033	19	334	10.7	1,138
11	245	10.0	768	22	215	10.6	806
14	198	9.9	665	25	231	10.6	738
17	211	9.9	434	28	198	10.6	689
20	122	9.4	238	31	192	10.5	616
23	186	9.7	401	Nov. 3	294	10.5	623
26	87	9.4	235	9	202	10.5	590
27	232	10.05	756	12	175	10.5	584
30	59	8.8	112	15	207	10.5	539
Aug. 3	80	9.0	290	18	325	10.6	778
6	48	8.8	146	21	259	10.7	660
9	56	8.9	185	24	235	10.65	618
12	64	9.2	241	27	328	10.85	973
15	205	10.2	736	Dec. 1	267	10.9	883
18	68	9.0	232	4	253	10.65	875
21	222	10.3	995	7	245	10.85	936
23	480	11.1	2,688	10	197	10.7	582
26	363	10.4	1,708	13	203	10.7	515
30	458	10.6	1,759	16	209	10.85	604

Note.—River frozen over from December 18 to December 31, 1909.

Daily gage height, in feet, of Rio Grande near San Marcial, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.45	10.45	10.45	10.5	11.4	11.5	10.9	8.55	10.5	10.55	10.5	10.9
2	10.5	10.4	10.5	10.5	11.4	11.5	10.9	8.35	10.3	10.5	10.5	10.85
3	10.4	10.4	10.5	10.5	11.4	11.55	10.75	8.65	10.65	10.5	10.5	10.8
4	10.4	10.4	10.55	10.55	11.0	11.6	10.6	9.0	10.5	10.45	10.6	10.65
5	10.4	10.4	10.7	10.6	10.8	11.4	10.5	9.05	10.6	10.4	10.45	10.7
6	10.5	10.45	10.8	10.6	10.95	11.2	10.4	8.8	12.05	10.4	10.4	10.8
7	10.5	10.35	10.8	10.65	11.55	11.2	10.3	8.95	13.3	10.4	10.4	10.85
8	10.4	10.4	10.7	10.7	12.1	11.6	10.2	9.0	12.5	10.4	10.35	10.9
9	10.4	10.45	10.6	10.6	12.5	12.4	10.5	8.95	11.6	10.4	10.5	10.75
10	10.55	10.55	10.55	10.5	12.65	12.65	10.2	8.95	11.95	11.15	10.5	10.7
11	10.45	10.5	10.55	10.4	12.5	12.65	10.0	9.05	12.2	10.75	10.5	10.6
12	10.4	10.45	10.6	10.4	12.3	12.7	10.0	9.0	12.05	10.8	10.4	10.55
13	10.4	10.5	10.6	10.5	12.1	12.7	10.05	8.95	11.8	10.8	10.45	10.65
14	10.35	10.4	10.5	10.6	12.1	12.6	9.95	9.75	11.7	10.8	10.5	10.95
15	10.4	10.3	10.5	10.6	12.3	12.25	9.9	9.9	11.4	10.8	10.5	10.95
16	10.35	10.3	10.5	10.6	12.25	12.0	9.9	9.4	11.35	10.7	10.45	10.9
17	10.5	10.4	10.4	10.6	12.2	11.95	9.9	9.45	11.35	10.7	10.45	10.75
18	10.4	10.5	10.4	10.9	12.05	11.85	9.85	9.1	11.4	10.7	10.55	10.7
19	10.45	10.4	10.5	11.15	12.1	11.7	9.75	9.2	11.35	10.7	10.65	10.9
20	10.45	10.4	10.6	11.3	12.05	11.7	9.45	9.1	11.3	10.7	10.65	10.7
21	10.5	10.45	10.45	11.85	12.15	11.9	9.4	10.4	11.2	10.6	10.7	10.7
22	10.5	10.55	10.3	12.0	12.25	11.8	9.35	11.7	10.95	10.6	10.7	10.7
23	10.5	10.55	10.2	11.95	12.3	11.8	9.55	11.25	10.8	10.6	10.65	10.7
24	10.4	10.6	10.2	12.15	12.3	11.65	9.4	10.55	10.8	10.6	10.6	10.7
25	10.45	10.6	10.35	11.8	12.25	11.45	9.05	10.1	10.85	10.6	10.7	10.7
26	10.45	10.5	10.4	11.45	12.15	11.5	10.1	10.3	10.65	10.6	10.75	10.7
27	10.5	10.5	10.4	11.3	11.85	11.35	10.0	10.6	10.7	10.6	10.85	10.7
28	10.35	10.4	10.5	10.9	11.7	11.2	9.6	10.4	10.6	10.6	10.95	10.7
29	10.35	....	10.5	10.7	11.3	11.1	9.1	10.35	10.6	10.6	11.05	10.85
30	10.35	....	10.6	11.0	11.3	10.9	8.85	10.4	10.6	10.5	10.9	11.15
31	10.5	....	10.6	....	11.5	....	8.8	10.5	....	10.5	....	11.4

Note.—River frozen over from December 18 to 31.

Daily discharge, in second-feet, of Rio Grande near San Marcial, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	555	685	525	870	2,980	4,130	2,260	60	1,550	1,060	620	[a]885
2	[a]565	620	525	[a]750	2,980	[a]4,140	[a]2,010	20	[a]1,090	940	620	900
3	560	[a]590	[a]495	750	[a]2,980	4,050	1,780	[a]145	1,520	[a]915	[a]625	915
4	605	605	680	800	2,760	3,960	1,550	290	1,330	840	680	[a]875
5	[a]650	620	970	855	2,610	[a]3,370	[a]1,400	325	[a]1,460	765	585	890
6	675	[a]665	[a]1,200	[a]855	[a]2,720	2,960	1,280	[a]145	[a]5,110	765	550	920
7	655	595	1,200	995	3,960	2,960	1,150	205	9,490	[a]765	545	[a]935
8	[a]580	615	1,070	1,140	5,340	[a]3,840	[a]1,030	225	7,010	765	510	880
9	580	[a]635	[a]940	[a]1,130	[a]6,340	6,220	1,420	[a]205	[a]4,230	765	[a]590	700
10	670	705	935	985	7,050	7,350	1,030	185	4,650	[a]2,150	590	[a]580
11	[a]645	680	965	845	7,160	[a]7,740	[a]770	205	4,880	1,200	590	500
12	670	[a]660	[a]1,040	[a]845	[a]7,180	7,890	770	[a]165	[a]4,300	1,320	[a]555	450
13	700	690	1,000	885	6,840	7,890	820	165	3,900	[a]1,320	540	[a]485
14	[a]715	620	870	925	6,840	[a]7,730	[a]715	515	3,760	1,320	555	665
15	720	[a]550	[a]835	[a]865	[a]7,110	6,760	590	[a]590	[a]3,320	1,320	[a]540	665
16	680	550	805	865	6,870	5,940	510	400	3,140	[a]1,280	570	[a]635
17	[a]725	590	675	865	6,750	[a]5,720	[a]435	420	3,030	1,230	630	545
18	705	[a]630	[a]645	[a]1,070	[a]6,380	5,260	415	[a]275	[a]3,000	1,190	[a]750	515
19	745	605	745	1,630	6,500	4,660	375	350	2,970	[a]1,140	750	635
20	[a]765	605	845	2,120	6,440	[a]4,500	[a]255	290	2,940	1,090	690	515
21	775	620	[a]735	[a]3,910	[a]6,560	4,850	220	[a]1.050	[a]2,880	855	[a]660	515
22	775	[a]645	680	4,080	6,690	4,480	200	3.950	2,220	[a]805	660	515
23	[a]775	615	665	3,790	6,750	[a]4,350	[a]315	[a]3,000	1,830	785	620	515
24	705	630	[a]710	[a]4,000	[a]6,750	4,230	280	1,920	[a]1,830	760	[a]575	515
25	695	[a]615	825	3,470	6,610	4,080	140	1,290	1,940	[a]740	680	515
26	[a]665	570	885	3,070	6,320	[a]4,120	[a]800	[a]1,570	1,510	720	745	515
27	685	570	[a]915	[a]2,900	[a]5,460	3,760	[a]700	1,760	[a]1,610	705	[a]870	515
28	645	[a]530	995	2,500	4,860	3,400	520	1,710	1,330	[a]690	1,040	515
29	[a]645	....	995	2,300	3,890	[a]3,160	260	1,700	1,260	690	1,100	665
30	665	....	[a]1,080	[a]2,540	[a]3,720	2,700	[a]130	[a]1,710	[a]1,180	615	920	965
31	[a]755	....	1,080	....	4,120	....	110	1,710	....	[a]615	....	1,210

[a] Date of measurement.

Monthly discharge of Rio Grande near San Marcial, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	775	555	676	41,554
February	705	530	618	34,334
March	1,200	495	856	52,622
April	4,080	750	1,753	104,340
May	7,180	2,610	5,468	336,238
June	7,890	2,700	4,873	289,983
July	2,260	110	782	48,080
August	3,950	20	856	52,661
September	9,490	1,090	3,009	179,048
October	2,150	615	972	59,742
November	1,100	510	665	39,580
December	1,210	450	679	41,752
The year	9,490	20	1,767	1,279,934

RIO GRANDE NEAR EL PASO, TEX.

This station was located at the pumping house of the smelter company, 3 miles north of El Paso, Tex. The bed of the stream at that point is composed of mud and is constantly shifting and changing. On May 1, 1897, the station was placed under the charge of W. W. Follett, consulting engineer, International Boundary Commission, and by him removed 1 mile farther up the river to Courchesne's limekiln.

Although the section is unstable and subject to overflow, it is still the best site for a station in the vicinity of El Paso, as the entire bed is constantly shifting for many miles above and below. On this account frequent discharge measurements are made in order to closely estimate the daily discharge.

River heights were measured at the masonry pump-foundation pier. As the pier was torn down in October, 1902, an inclined wooden gage was established some 60 feet upstream. This has since been moved about 300 feet downstream.

Discharge measurements of Rio Grande near El Paso, Tex., in 1909.

[By T. A. Stiles and W. L. Follett.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	204	7.9	443	June 28	604	10.4	3,175
5	197	7.9	418	30	488	9.9	2,170
9	150	7.7	276	July 19	47	6.9	76
14	172	8.0	370	22	33	6.4	28
16	214	8.1	509	25	30	6.05	15
19	161	8.0	359	Aug. 21	21	6.1	23
Feb. 5	192	8.25	363	24	16	6.0	14
9	159	8.1	390	25	402	9.35	1,864
12	187	8.3	476	28	219	8.25	741
15	176	8.2	392	31	250	8.5	1,070
18	116	7.8	224	Sept. 3	205	8.0	584
21	169	8.1	329	6	187	7.95	593
25	84	7.5	145	9	991	11.95	5,574
28	87	7.3	163	12	727	11.45	4,480
Mar. 3	94	7.4	159	15	577	10.5	3,289
6	22	7.1	33	18	463	10.0	2,360
9	180	8.1	470	22	364	9.4	1,674
13	325	9.15	1,084	24	258	8.9	1,107
16	274	8.8	858	27	265	8.75	1,059
20	108	7.6	230	30	237	8.2	690
24	143	8.1	433	Oct. 3	220	8.4	869
28	125	8.05	358	6	147	7.9	431
31	103	7.8	186	9	151	7.8	342
Apr. 3	107	7.8	200	12	309	9.2	1,573
6	75	7.4	113	16	207	8.3	754
9	42	6.85	49	18	218	8.4	604
12	226	8.6	721	21	221	8.4	705
15	114	7.8	267	24	153	8.2	516
18	130	7.9	260	27	152	8.1	481
21	92	7.6	129	29	151	8.1	486
24	657	11.25	3,834	31	124	8.0	416
27	605	10.55	3,089	Nov. 3	170	8.1	401
30	342	9.5	1,625	6	142	7.95	336
May 3	446	10.2	2,238	9	132	7.75	299
6	404	9.85	2,028	12	128	7.6	274
9	441	10.1	2,265	15	152	7.9	364
12	1,060	12.3	6,434	18	146	7.8	358
15	1,027	12.1	6,044	21	136	7.7	288
18	1,011	12.2	6,548	24	243	8.3	555
21	848	11.7	5,072	27	174	8.0	399
26	959	12.1	5,755	Dec. 1	225	8.2	506
30	652	10.7	3,580	5	243	8.4	779
June 3	641	10.6	3,194	9	217	8.4	463
6	492	10.0	2,461	12	176	8.2	364
9	525	10.1	2,710	15	127	7.8	233
12	980	11.9	5,531	19	230	8.3	475
15	967	12.1	6,168	24	111	7.5	191
19	886	11.7	5,118	28	85	7.2	146
22	642	10.7	3,670	31	58	6.95	101
25	665	10.9	3,599				

Daily gage height, in feet, of Rio Grande near El Paso, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.85	8.35	7.8	7.75	9.3	10.35	9.85	....	8.3	8.2	8.0	8.1
2	7.9	8.35	7.75	7.7	9.5	10.5	9.6	....	8.3	8.1	8.0	8.35
3	7.95	8.2	7.45	7.9	10.1	10.55	9.15	....	8.05	8.15	8.05	8.45
4	7.9	8.25	7.25	7.8	10.3	10.5	9.3	....	7.9	8.25	7.9	8.25
5	7.9	8.3	7.15	7.75	9.85	10.3	8.95	....	7.85	8.05	7.8	8.45
6	7.9	8.05	7.1	7.4	9.8	10.0	9.0	....	8.0	7.9	7.8	8.5
7	7.9	7.9	7.05	7.4	9.6	9.85	8.9	....	8.1	7.75	7.95	8.3
8	7.85	7.8	6.95	7.2	9.6	9.6	8.45	....	8.95	7.8	7.75	8.3
9	7.7	8.0	7.8	7.0	10.3	9.9	8.3	....	11.75	7.85	7.7	8.35
10	7.5	8.1	8.4	8.15	11.1	10.6	8.25	....	11.75	7.7	7.65	8.45
11	7.2	8.2	8.3	8.85	11.95	11.35	7.95	....	11.15	7.85	7.7	8.5
12	7.85	8.25	8.85	8.5	12.2	11.9	7.8	....	11.65	8.55	7.6	8.25
13	7.95	8.05	9.2	8.05	12.5	12.15	7.85	....	11.05	8.75	7.65	8.2
14	8.0	8.1	9.0	7.85	12.5	12.15	7.7	....	10.5	8.3	7.8	7.95
15	8.35	8.2	9.0	7.9	12.2	12.15	7.5	....	10.5	8.3	7.9	7.8
16	8.1	8.2	8.85	7.8	11.85	12.15	8.0	....	10.25	8.3	7.9	7.7
17	8.0	8.0	8.85	8.0	12.0	12.2	7.55	....	10.1	8.3	7.8	7.65
18	8.15	7.85	8.55	7.95	12.1	11.8	7.3	....	9.9	8.35	7.75	8.05
19	8.1	7.75	8.05	8.15	12.06	11.6	6.95	....	9.8	8.3	7.7	8.3
20	7.95	7.7	7.8	7.8	11.8	11.5	6.5	....	9.7	8.2	7.75	8.15
21	7.75	8.1	7.75	7.8	11.7	11.1	6.6	6.15	9.4	8.35	7.7	7.8
22	7.65	8.1	7.9	9.1	11.65	10.75	6.55	6.1	9.4	8.4	8.0	7.6
23	7.65	8.0	8.0	10.3	11.6	10.7	6.15	6.05	9.2	8.35	8.25	7.55
24	8.05	7.7	8.05	11.05	11.95	10.7	6.1	6.05	8.95	8.15	8.25	7.5
25	7.95	7.55	8.6	11.2	12.1	10.85	6.05	10.51	8.85	8.0	7.95	7.5
26	7.9	7.45	8.4	11.2	12.05	10.75	5.95	9.4	8.8	8.15	7.85	7.45
27	7.95	7.4	8.2	10.75	12.0	10.65	5.9	8.2	8.75	8.15	8.0	7.3
28	7.95	7.3	8.1	10.1	11.4	10.45	....	8.05	8.35	8.05	7.75	7.2
29	7.95	....	8.1	9.8	11.0	10.15	....	8.8	8.25	8.05	7.8	7.15
30	7.9	....	7.95	9.45	10.6	9.9	....	8.65	8.2	8.15	7.85	7.1
31	8.05	....	7.8	....	10.4	....	....	8.45	....	8.0	....	7.0

NOTE.—No flow July 28 to August 20.

Daily discharge, in second-feet, of Rio Grande near El Paso, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	425	425	365	175	1,450	3,040	2,030	....	875	690	400	[a]460
2	[a]445	425	340	165	1,620	3,130	1,710	....	875	600	380	655
3	470	335	[a]185	[a]230	[a]2,150	[a]3,160	1,170	....	[a]635	[a]645	[a]380	760
4	425	365	95	200	2,300	3,070	1,350	....	535	735	340	630
5	[a]420	[a]395	55	190	2,030	2,830	930	....	520	560	310	[a]820
6	420	305	[a]35	[a]115	[a]2,000	[a]2,460	990	....	[a]625	[a]430	[a]310	760
7	420	265	25	115	1,790	2,280	890	....	780	300	335	560
8	380	250	10	90	1,790	1,980	530	....	1,840	340	300	480
9	[a]275	[a]350	[a]340	[a]65	[a]2,640	[a]2,420	440	....	[a]5,140	[a]385	[a]290	[a]435
10	195	390	645	545	4,160	3,500	415	....	5,140	255	280	490
11	75	435	590	810	5,770	4,670	295	....	3,820	385	290	515
12	315	[a]455	915	[a]680	[a]6,240	[a]5,530	250	....	[a]4,880	[a]1,000	[a]275	[a]390
13	350	360	[a]1,110	410	6,830	6,110	265	....	3,980	1,160	290	365
14	[a]370	365	985	295	6,830	6,190	220	....	3,290	755	335	280
15	620	[a]390	985	[a]320	[a]6,250	[a]6,270	160	....	[a]3,290	755	[a]365	[a]235
16	[a]510	390	[a]890	255	5,640	6,300	310	....	2,820	[a]755	375	215
17	420	310	885	305	6,040	6,430	175	....	2,540	635	345	205
18	480	[a]245	730	[a]275	[a]6,350	5,380	125	....	[a]2,250	[a]560	[a]330	375
19	[a]420	205	465	370	6,090	[a]4,970	[a]80	....	2,130	550	310	[a]475
20	345	190	[a]335	215	5,430	4,830	30	....	2,020	490	320	425
21	290	[a]330	290	[a]215	[a]5,070	4,250	40	[a]30	1,670	660	[a]290	300
22	260	330	350	1,640	4,990	[a]3,740	[a]35	25	[a]1,670	705	420	225
23	260	300	395	2,880	4,900	3,550	20	20	1,450	660	530	210
24	350	205	[a]415	[a]3,630	5,500	3,440	15	[a]20	[a]1,170	[a]500	[a]535	[a]190
25	330	[a]160	735	3,780	5,750	[a]3,530	[a]15	[a]2,680	1,090	450	375	190
26	320	155	600	3,780	[a]5,670	3,470	10	1,910	1,070	500	320	180
27	330	165	465	[a]3,300	5,600	3,380	5	690	[a]1,060	[a]500	[a]400	160
28	330	[a]165	[a]395	2,460	4,670	[a]3,210	....	[a]540	790	460	300	[a]145
29	330	....	395	2,050	4,050	2,670	....	1,420	725	[a]465	325	135
30	320	....	290	[a]1,460	[a]3,430	[a]2,170	....	1,250	[a]690	520	345	130
31	355	....	[a]185	....	3,120	....	....	[a]1,010	....	[a]415	....	[a]110

[a] Date of measurement.

NOTE.—No flow July 28 to August 20.

Monthly discharge of Rio Grande near El Paso, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	620	75	363	22,324
February	455	155	309	17,177
March	1,110	10	468	28,760
April	3,780	65	1,034	61,527
May	6,830	1,450	4,392	270,050
June	6,430	1,980	3,932	233,970
July	2,030	0	403	24,803
August	2,680	0	310	19,031
September	5,140	520	1,979	117,759
October	1,160	255	575	35,345
November	535	275	347	20,268
December	820	110	371	22,820
The year	6,830	0	1,207	873,834

RIO GRANDE ABOVE PRESIDIO, TEX.

This station was established April 4, 1900, by the International Boundary Commission. It was originally located 9 miles above Presidio and 18 miles above the mouth of Rio Conchos, one of the principal tributaries of the Rio Grande, and about 200 miles below El Paso. The station was in a straight stretch of the river, but in the bight of a long bend. In 1905 the river began to erode a cut-off across this bend, and the spring flood of 1905 deepened this channel to such an extent that more water passed through it than through the station, and it became necessary to abandon the location. In September, 1905, the station was moved 8 miles farther upstream and rebuilt. Its location was far enough above the mouth of Rio Conchos to be free from the effects of backwater from that stream. Caving banks necessitated the abandonment of this upper site, and the station was moved back to the original site, at the Haciendita, July 6, 1909. A new gage was established whose readings are not comparable with the old ones. Changes of river bed have closed the crevasse which threatened in 1905, and frequent discharge measurements are necessary to determine closely the daily discharge.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande above Presidio, Tex., in 1909.

[By W. T. Millington.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft*
Jan. 3	133	3.7	163	July 6	446	8.6	1,736
6	80	3.5	105	9	435	8.4	1,495
9	83	3.6	99	12	285	7.4	625
12	91	3.55	129	15	201	6.7	289
15	82	3.45	141	18	73	5.4	56
18	62	3.3	88	21	159	6.3	171
21	110	3.6	169	24	120	5.9	97
24	128	3.6	195	27	126	6.0	106
27	92	3.45	139	30	173	6.35	189
30	63	3.3	94	Aug. 3	80	5.4	73
Feb. 3	63	3.2	86	6	81	5.4	69
6	62	3.2	77	9	61	5.2	36
9	70	3.35	103	12	22	4.5	8
12	97	3.6	115	14	148	7.2	325
15	73	3.3	99	18	20	4.4	8
18	77	3.3	96	Sept. 2	75	5.5	41
21	72	3.4	101	5	152	6.5	162
24	70	3.3	95	8	129	6.3	119
27	71	3.25	90	11	133	6.4	139
Mar. 3	64	3.3	69	14	842	10.95	5,763
6	49	3.1	43	17	623	9.75	2,840
9	45	2.9	32	20	535	9.3	1,859
12	26	2.75	18	23	422	8.8	1,138
15	23	2.6	13	26	338	8.2	691
21	145	4.0	223	29	278	7.55	392
24	94	3.7	116	Oct. 3	210	7.2	258
27	76	3.3	79	6	195	6.9	191
30	74	3.0	73	9	203	6.9	217
Apr. 2	34	2.6	28	12	155	6.8	139
5	69	3.0	78	15	137	6.45	109
8	43	2.8	56	18	192	6.9	219
11	38	2.8	42	21	222	7.1	284
14	21	2.6	12	24	224	7.1	268
29	526	5.7	2,308	27	229	7.3	340
May 2	478	5.6	1,157	30	213	7.0	233
5	333	4.6	547	Nov. 2	175	7.1	187
8	436	5.2	992	5	173	7.0	180
11	307	4.5	493	8	148	6.9	128
14	572	5.8	2,586	11	129	6.8	101
16	760	6.3	3,474	14	121	6.7	86
19	968	6.9	5,158	17	107	6.6	79
22	1,035	7.0	4,399	20	92	6.6	65
26	1,040	6.4	4,076	23	118	6.8	91
30	1,049	6.5	3,815	26	121	6.8	109
June 2	941	6.0	2,539	29	121	6.6	109
5	870	5.5	1,920	Dec. 3	152	6.9	135
8	798	5.3	1,559	6	146	6.9	139
11	976	5.9	3,250	9	180	7.1	213
14	856	6.3	3,007	12	188	7.3	244
17	1,052	6.9	4,832	15	187	7.4	193
20	968	6.9	3,160	19	184	7.4	155
23	1,099	6.9	5,514	21	176	7.2	140
26	906	6.1	3,607	24	155	7.0	174
29	842	5.9	2,483	27	162	7.2	204
July 2	733	5.5	1,631	30	120	6.9	131

NOTE.—Gage heights, July 6 to December 30, taken on new gage, whose readings are not comparable with old gage.

Daily gage height, in feet, of Rio Grande above Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	3.2	3.1	2.6	6.15	6.3	5.7	5.65	5.25	7.5	7.1	7.05
2	3.7	3.3	3.1	2.6	5.5	5.95	5.45	5.55	5.45	7.35	7.05	7.0
3	3.65	3.25	3.3	3.2	4.85	5.75	5.2	5.4	5.5	7.15	6.95	6.9
4	3.6	3.25	3.2	3.1	4.7	5.65	5.05	5.65	6.7	7.0	6.95	6.85
5	3.6	3.2	3.1	3.0	4.55	5.55	5.0	5.45	6.45	6.9	6.95	6.9
6	3.5	3.2	3.1	2.9	4.7	5.5	8.6	5.45	6.85	6.9	6.9	6.8
7	3.6	3.2	2.95	2.8	5.0	5.4	8.95	5.3	6.9	6.85	6.9	6.9
8	3.6	3.2	2.9	2.8	5.25	5.35	10.4	5.2	6.2	6.8	6.9	6.8
9	3.6	3.35	2.9	2.8	5.05	5.85	7.8	5.1	5.85	6.85	6.85	7.15
10	3.65	3.5	2.85	2.8	4.7	5.9	7.85	4.85	6.35	6.85	6.8	7.2
11	3.6	3.6	2.85	2.8	4.55	5.9	8.15	4.65	6.3	6.95	6.8	7.2
12	3.6	3.6	2.8	2.7	4.8	5.95	7.3	4.45	6.55	6.8	6.7	7.3
13	3.6	3.45	2.7	2.7	5.3	6.05	6.95	6.8	10.25	6.7	6.7	7.35
14	3.5	3.3	2.65	2.6	5.8	6.3	6.7	8.7	11.0	6.55	6.75	7.3
15	3.45	3.3	2.6	2.6	6.0	6.55	6.7	5.45	11.15	6.45	6.7	7.3
16	3.4	3.3	2.6	......	6.3	6.65	6.5	4.95	10.45	6.4	6.65	7.3
17	3.4	3.2	......	......	6.6	6.85	5.95	4.7	9.75	6.45	6.6	7.3
18	3.3	3.3	......	......	6.8	6.55	5.3	4.4	9.85	6.95	6.55	7.45
19	3.35	3.4	3.8	......	6.85	6.9	6.3	4.55	9.45	7.1	6.6	7.4
20	3.5	3.4	4.0	......	7.0	6.9	6.3	4.5	9.3	7.05	6.6	7.3
21	3.6	3.4	4.0	......	7.05	6.9	6.25	4.3	9.5	7.15	6.6	7.2
22	3.6	3.25	3.9	......	7.0	6.95	6.05	......	8.8	7.2	6.6	7.0
23	3.6	3.3	3.75	......	7.1	6.9	5.95	......	8.8	7.15	6.8	7.0
24	3.6	3.3	3.7	......	7.15	6.55	5.9	......	8.5	7.15	6.8	6.95
25	3.5	3.35	3.6	......	6.75	6.05	5.8	......	8.35	7.2	6.8	6.9
26	3.5	3.2	3.45	......	6.4	6.1	5.85	......	8.15	7.1	6.8	7.15
27	3.45	3.25	3.3	......	6.3	5.8	6.0	......	7.9	7.25	6.8	7.1
28	3.4	3.1	3.2	3.9	6.45	5.85	7.4	......	7.65	7.1	6.65	7.0
29	3.3	......	3.1	5.7	6.5	5.9	7.6	......	7.55	7.0	6.6	7.0
30	3.25	......	3.0	5.7	6.5	5.7	6.5	......	7.45	7.0	6.6	6.9
31	3.2	......	2.9	......	6.5	......	5.95	......	......	7.1	......	6.8

NOTE.—On July 6 station was moved back to "The Haciendita," 8 miles above mouth of Conchas, and a new gage established not comparable with old gage.

No flow March 17–18, April 16–27, August 22–31.

Daily discharge, in second-feet, of Rio Grande above Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	165	85	70	30	2,430	3,370	2,060	105	30	380	225	150
2	165	90	65	[a]30	[a]1,100	[a]2,480	[a]1,580	95	[a]40	320	[a]185	145
3	[a]150	[a]90	[a]70	100	700	2,230	1,330	[a]75	40	[a]245	175	[a]135
4	135	90	55	90	610	2,100	1,180	110	190	215	175	125
5	135	80	45	[a]80	[a]510	[a]1,980	1,130	80	[a]150	190	[a]170	135
6	[a]105	[a]75	[a]45	65	620	1,920	[a]1,740	[a]80	265	[a]190	150	[a]120
7	120	80	35	55	845	1,740	2,440	55	280	185	140	140
8	110	85	30	[a]55	[a]1,030	[a]1,650	5,340	35	[a]110	180	[a]130	120
9	[a]100	[a]105	[a]30	50	885	3,110	[a]975	[a]30	75	[a]200	115	[a]220
10	120	110	25	45	635	3,250	1,020	20	135	185	100	230
11	125	115	25	[a]40	[a]530	[a]3,250	1,280	10	125	200	[a]100	230
12	[a]140	[a]115	[a]20	25	975	3,000	[a]575	[a]5	175	[a]140	85	[a]245
13	150	110	15	25	1,780	2,850	410	285	4,870	130	85	230
14	140	100	15	[a]10	[a]2,590	[a]3,010	290	[a]925	[a]5,830	115	[a]90	195
15	[a]140	[a]100	[a]15	10	2,940	3,770	[a]290	130	6,060	[a]110	90	[a]175
16	125	100	10	0	[a]3,480	4,070	255	70	4,450	100	85	165
17	125	90	0	0	4,320	[a]4,680	155	40	[a]2,840	110	[a]80	155
18	[a]90	[a]95	0	0	4,880	3,580	[a]45	[a]10	2,990	[a]235	70	175
19	100	100	155	0	[a]5,020	3,720	170	20	2,170	285	70	[a]155
20	140	100	225	0	5,000	[a]3,160	170	15	[a]1,860	265	[a]65	145
21	[a]170	[a]100	[a]225	0	4,770	3,950	[a]160	5	2,150	[a]300	65	[a]140
22	180	90	185	0	[a]4,400	4,830	125	0	1,140	310	65	125
23	190	95	135	0	4,670	[a]5,510	105	0	[a]1,140	290	[a]90	150
24	[a]195	[a]95	[a]115	0	4,870	4,680	[a]95	0	915	[a]285	95	[a]170
25	160	100	105	0	4,440	3,490	90	0	800	305	105	160
26	160	85	95	0	[a]4,080	[a]3,610	90	0	[a]670	270	[a]110	195
27	[a]140	[a]90	[a]80	0	3,840	2,410	[a]105	0	555	[a]320	120	[a]190
28	125	75	80	210	3,950	2,440	625	0	440	270	105	155
29	95	......	75	[a]2,310	3,920	[a]2,480	725	0	[a]390	235	[a]110	155
30	[a]85	......	[a]75	2,310	[a]3,920	2,060	[a]250	0	360	[a]235	110	[a]130
31	80	......	70	......	3,920	......	140	0	......	265	......	105

[a] Date of measurement.

Monthly discharge of Rio Grande above Presidio, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	196	80	134	8,251
February	115	75	94	5,246
March	225	0	71	4,344
April	2,310	0	185	10,988
May	5,020	510	2,828	173,871
June	5,510	1,650	3,146	187,200
July	5,340	45	806	49,478
August	925	0	71	4,364
September	6,060	30	1,375	81,808
October	380	100	228	14,103
November	225	65	112	6,664
December	245	105	163	10,046
The year	6,060	0	768	556,273

RIO GRANDE BELOW PRESIDIO, TEX.

The station was established April 8, 1900, by the International Boundary Commission. It is 6 miles below Presidio, 7 miles below the mouth of the Rio Conchos, and about 215 miles below El Paso. It is at the west end of the canyon section of the Rio Grande. The discharge at this station minus the discharge at the station above Presidio, Tex., is the discharge of Rio Conchos, except at rare intervals, when some rain water enters the Rio Grande from the north.

The river is fairly straight at the station and for one-fourth mile above and below. The right bank is a rocky bluff. The left bank is an alluvial deposit and overflows for 750 feet back from the river, where gravel hills are found. The bed is of shifting sand and is affected by a drainage line called Alamos Creek, which reaches the river one-fourth mile below the station. This creek is subject to torrential floods, which bring large quantities of bowlders and gravel into the Rio Grande, forming a temporary dam, which remains, throwing backwater onto the gage, until a flood in the river scours it out. The extreme floods come from the Rio Conchos, the highest recorded gage height being 26.35 feet on September 11, 1904. Frequent discharge measurements are made to determine closely the daily flow.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande below Presidio, Tex., in 1909.

[By W. T. Millington.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 4	650	6.8	802	July 7	2,137	11.9	10,407
7	625	6.8	704	10	2,434	12.8	14,819
10	626	6.8	781	13	2,201	12.15	10,396
13	589	6.8	603	16	1,769	10.7	5,945
16	602	6.8	652	19	1,269	9.5	2,467
19	596	6.7	564	22	1,217	9.4	2,530
22	593	6.8	509	25	1,139	9.0	1,993
25	688	6.8	665	28	1,419	10.15	4,030
28	627	6.8	501	31	1,555	10.3	4,466
31	605	6.6	491	Aug. 4	1,552	10.4	6,089
Feb. 4	659	6.8	900	7	1,534	9.75	5,001
7	626	6.7	616	10	1,663	10.4	7,110
10	623	6.8	617	13	1,546	10.3	5,735
14	612	6.75	591	16	1,835	10.75	8,114
16	617	6.7	569	19	2,388	11.8	12,157
19	561	6.6	481	22	1,757	10.2	7,619
22	547	6.55	446	25	1,476	9.65	4,215
25	506	6.6	358	28	1,486	9.6	4,965
28	495	6.6	357	31	1,152	8.6	2,360
Mar. 4	482	6.5	272	Sept. 3	2,448	12.7	14,222
7	510	6.5	238	6	1,619	9.9	6,380
10	508	6.45	208	9	1,385	9.0	4,011
13	443	6.35	143	12	1,740	9.8	7,578
16	423	6.3	158	15	2,305	11.2	10,796
19	406	6.2	174	18	2,406	11.4	12,633
22	554	6.85	474	21	2,087	10.5	7,534
25	465	6.6	349	24	1,763	9.8	5,298
28	428	6.4	280	27	1,320	9.2	3,564
31	403	6.25	312	30	1,188	8.6	2,480
Apr. 3	425	6.3	393	Oct. 4	919	8.2	1,702
6	433	6.35	405	7	848	8.1	1,411
9	379	6.2	307	10	780	7.9	1,065
12	382	6.1	351	13	799	7.8	981
15	352	6.0	320	16	614	7.6	911
18	324	5.95	276	19	653	7.8	1,072
21	305	5.9	197	22	646	7.7	1,084
24	329	5.9	190	25	604	7.7	935
27	338	5.9	202	28	628	7.7	1,094
30	1,127	7.4	1,128	31	581	7.5	702
May 1	1,236	8.0	2,740	Nov. 3	580	7.4	755
4	1,145	7.7	2,054	6	561	7.3	644
7	1,203	7.8	2,548	9	564	7.3	625
10	1,172	7.7	2,085	12	558	7.2	595
13	904	7.9	1.470	15	550	7.2	580
17	1,116	8.6	3.719	18	526	7.1	529
20	1,256	8.9	5,983	21	509	7.1	462
24	1,359	9.05	5,452	24	511	7.1	506
27	1,350	9.1	5,338	27	512	7.1	466
31	1,338	9.1	4.509	30	514	7.0	478
June 3	894	8.6	1,500	Dec. 4	543	7.1	584
6	805	8.4	1,286	7	518	7.0	512
9	753	8.3	1,036	10	594	7.2	639
12	666	8.0	719	13	588	7.3	539
15	1,791	10.7	6,958	16	575	7.2	468
18	1,505	10.2	5,242	20	569	7.2	596
21	1,512	10.1	4,361	23	536	7.1	486
24	1,242	10.35	6,059	26	531	7.1	500
27	1,013	9.5	3,565	28	1,971	10.85	8,492
30	1,117	9.7	4,327	31	1,209	9.0	3,205

Daily gage height, in feet, of Rio Grande below Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.7	6.7	6.6	6.15	7.85	8.95	9.65	10.85	9.5	8.5	7.5	7.05
2	6.7	6.7	6.55	6.2	8.0	8.75	9.65	11.2	12.15	8.4	7.4	7.1
3	6.9	6.75	6.5	6.3	7.85	8.55	9.3	10.65	12.5	8.3	7.4	7.1
4	6.8	6.8	6.5	6.4	7.65	8.45	9.2	10.45	11.25	8.2	7.4	7.1
5	6.8	6.8	6.5	6.3	7.5	8.4	9.2	10.5	10.25	8.2	7.3	7.05
6	6.8	6.7	6.5	6.3	7.5	8.4	11.0	10.5	9.95	8.15	7.3	7.0
7	6.8	6.7	6.5	6.2	7.85	8.4	11.55	9.75	9.45	8.1	7.3	7.0
8	6.85	6.7	6.5	6.2	7.9	8.3	12.6	10.05	9.1	8.0	7.3	7.0
9	6.8	6.7	6.4	6.2	7.95	8.3	12.5	10.1	9.1	8.0	7.3	7.1
10	6.8	6.75	6.4	6.2	7.7	8.25	12.8	10.45	9.65	7.9	7.3	7.15
11	6.85	6.8	6.4	6.1	7.6	8.15	12.3	10.3	10.15	7.9	7.2	7.3
12	6.8	6.8	6.4	6.1	7.6	8.0	12.8	10.3	9.9	7.85	7.2	7.3
13	6.8	6.8	6.4	6.1	7.85	8.1	12.0	10.35	10.65	7.75	7.2	7.25
14	6.8	6.75	6.4	6.1	8.1	8.35	11.15	10.85	11.1	7.6	7.2	7.2
15	6.8	6.7	6.35	6.0	8.35	10.55	10.4	10.4	11.2	7.6	7.2	7.15
16	6.8	6.7	6.3	6.0	8.5	9.6	10.65	10.8	11.6	7.6	7.2	7.2
17	6.75	6.7	6.25	6.0	8.6	10.0	10.45	11.7	11.4	7.6	7.1	7.1
18	6.7	6.7	6.2	6.0	8.75	10.3	9.95	11.8	11.4	7.75	7.1	7.15
19	6.7	6.6	6.2	6.0	8.85	10.15	9.5	11.65	11.0	7.8	7.1	7.2
20	6.7	6.6	6.85	6.0	8.95	10.1	9.65	10.8	10.95	7.7	7.1	7.2
21	6.8	6.6	6.85	5.9	9.0	10.15	9.55	10.45	10.5	7.7	7.1	7.2
22	6.8	6.55	6.8	5.9	9.05	10.4	9.35	10.1	10.4	7.75	7.1	7.1
23	6.8	6.5	6.8	5.9	9.05	10.65	9.1	9.75	10.05	7.7	7.1	7.1
24	6.9	6.5	6.7	5.9	9.05	10.3	9.0	9.95	9.85	7.7	7.1	7.1
25	6.8	6.55	6.6	5.9	9.1	9.75	9.0	9.65	9.55	7.7	7.1	7.1
26	6.8	6.6	6.55	5.9	9.1	9.65	9.75	9.05	9.25	7.6	7.1	7.1
27	6.8	6.6	6.5	5.9	9.1	9.45	9.8	9.8	9.2	7.6	7.1	7.15
28	6.75	6.6	6.4	5.9	9.05	9.3	10.2	9.6	9.1	7.7	7.0	10.75
29	6.7	......	6.4	7.4	9.15	9.5	10.5	9.6	8.7	7.6	7.0	9.9
30	6.7	......	6.3	7.4	9.1	9.7	10.45	8.75	8.6	7.5	7.0	9.2
31	6.6	......	6.2	......	9.1	......	10.35	8.6	......	7.5	......	9.0

Daily discharge, in second-feet, of Rio Grande below Presidio, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	640	635	355	290	[a]2,340	3,610	4,190	6,670	4,910	2,280	740	530
2	675	695	310	330	2,740	2,400	4,190	8,070	12,630	2,090	710	585
3	815	795	270	[a]395	2,400	[a]1,450	3,220	6,710	[a]13,660	1,890	[a]755	585
4	[a]800	[a]900	[a]270	420	[a]1,900	1,340	2,950	[a]6,210	10,160	[a]1,700	750	[a]585
5	770	830	260	395	1,450	1,290	2,950	6,260	7,360	1,660	650	550
6	735	685	250	[a]395	1,450	[a]1,290	7,920	6,260	[a]6,510	1,540	[a]645	510
7	[a]705	[a]615	[a]240	335	[a]2,700	1,240	[a]9,440	[a]5,000	5,200	[a]1,410	640	[a]510
8	755	600	240	320	2,850	1,090	13,840	5,970	4,280	1,240	630	510
9	755	585	180	[a]305	3,000	[a]1,040	13,350	6,130	[a]4,270	1,240	[a]625	575
10	[a]780	[a]590	[a]180	335	[a]2,090	985	[a]14,820	[a]7,260	6,200	[a]1,070	625	[a]605
11	745	615	180	325	1,380	875	11,420	6,450	7,990	1,060	595	645
12	665	615	175	[a]350	980	[a]720	14,820	6,090	[a]7,810	1,020	[a]595	595
13	[a]605	615	[a]165	350	[a]1,320	950	[a]9,940	[a]5,880	9,530	[a]965	590	[a]505
14	620	[a]590	175	350	2,110	1,530	7,330	7,730	10,570	910	585	470
15	635	570	165	[a]320	2,910	[a]6,610	5,020	6,720	[a]10,800	910	[a]580	435
16	[a]650	[a]570	[a]160	310	3,400	3,190	[a]5,790	[a]8,310	12,410	[a]910	580	[a]470
17	610	555	160	300	[a]3,720	4,560	5,220	11,770	12,220	910	530	430
18	575	545	160	[a]300	4,620	[a]5,540	3,770	12,160	[a]12,630	1,030	[a]530	495
19	[a]565	[a]480	[a]175	275	5,380	4,900	[a]2,470	[a]11,730	10,370	[a]1,070	505	565
20	530	480	475	255	[a]6,130	4,550	2,780	9,320	10,090	1,020	485	[a]595
21	545	475	475	[a]195	6,040	[a]4,510	2,700	8,320	[a]7,530	1,050	[a]460	595
22	[a]510	[a]445	[a]450	195	5,940	5,580	[a]2,460	[a]7,320	7,210	[a]1,120	475	485
23	560	385	450	190	5,700	6,640	2,130	5,680	6,100	1,030	490	[a]485
24	665	345	400	[a]190	[a]5,450	[a]5,910	1,990	5,700	[a]5,440	980	[a]505	490
25	[a]665	[a]335	[a]350	195	5,510	4,300	[a]1,990	[a]4,210	4,570	[a]940	495	495
26	610	360	330	200	5,430	4,010	3,320	2,950	3,710	910	480	[a]500
27	555	360	315	[a]200	[a]5,340	[a]3,460	3,410	5,190	[a]3,560	960	[a]465	550
28	[a]475	[a]355	[a]280	200	4,980	3,160	[a]4,180	[a]4,960	3,380	[a]1,090	425	[a]8,200
29	480	......	310	1,130	5,070	3,740	5,050	4,960	2,660	935	450	5,780
30	510	......	300	[a]1,130	4,720	[a]4,330	4,900	2,750	[a]2,480	780	[a]480	3,770
31	[a]490	......	[a]290	......	[a]4,510	......	[a]4,610	[a]2,360	......	[a]700	......	[a]3,200

[a] Date of measurement.

Monthly discharge of Rio Grande below Presidio, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	815	475	635	39,065
February	900	335	558	30,992
March	475	160	274	16,850
April	1,130	190	349	20,787
May	6,130	980	3,663	225,243
June	6,640	720	3,160	188,033
July	14,820	1,990	5,876	361,329
August	12,160	2,360	6,616	406,810
September	13,660	2,480	7,541	448,740
October	2,280	700	1,175	72,239
November	755	425	569	33,858
December	8,200	430	1,139	70,016
The year	14,820	160	2,630	1,913,962

RIO GRANDE NEAR LANGTRY, TEX.

This station was established in April, 1900, by the International Boundary Commission. It is located one-half mile south of Langtry station, on the Southern Pacific Railroad, and is about 440 miles below El Paso, Tex., at the east end of the canyon section of the Rio Grande, and a short distance to the west of the mouth of Pecos River, one of the principal tributaries of the Rio Grande.

The right (Mexican) bank is a rock bluff; the left bank is alluvial deposit for 200 feet back to a rock bluff. As the river is constantly shifting, because of alluvial deposits, frequent discharge measurements are made in order to determine closely the daily flow.

Observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande near Langtry, Tex., in 1909.

[By E. E. Winter.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	390	0.35	661	Apr. 17	298	0.0	420
7	413	.5	770	22	291	− .05	379
12	378	.35	655	27	294	− .05	387
18	388	.4	671	May 2	281	− .05	380
23	398	.4	694	6	605	1.6	1,596
28	403	.4	723	10	471	.95	1,068
Feb. 2	383	.4	684	14	568	1.5	1,379
7	371	.3	630	18	709	1.8	2,132
12	376	.3	626	23	941	2.8	3,991
17	371	.3	628	28	1,073	3.15	4,763
21	375	.35	655	June 2	989	3.0	4,486
25	370	.3	631	6	835	2.3	2,929
Mar. 2	348	.3	565	10	824	2.3	3,027
7	350	.3	573	15	658	1.8	2,063
13	337	.25	546	19	1,073	3.2	4,919
17	350	.25	549	23	1,048	3.1	4,548
22	310	.1	443	27	1,059	3.2	4,761
28	305	.05	416	July 2	922	2.7	3,858
Apr. 2	333	.15	511	8	1,056	3.5	5,316
7	318	.15	503	12	2,374	7.5	16,369
12	317	.05	466	16	1,577	5.1	9,501

Discharge measurements of Rio Grande near Langtry, Tex., in 1909—Continued.

Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*
July 20	1,305	3.9	6,472
25	1,209	3.5	5,374
28	1,269	3.7	6,301
Aug. 3	1,455	4.45	7,924
7	1,474	4.7	8,952
12	1,385	4.05	7,027
16	1,463	4.7	9,189
21	1,858	5.8	12,031
24	1,336	3.9	6,869
28	1,066	3.1	4,577
Sept. 2	862	2.5	3,336
6	1,754	5.35	11,319
13	1,131	3.3	5,482
17	1,713	5.15	10,378
21	1,642	5.4	11,112
25	1,374	4.0	7,350
27	1,199	3.4	5,783
Oct. 2	895	2.45	3,280
7	746	1.9	2,333
Oct. 11	678	1.7	1,956
15	628	1.6	1,672
20	595	1.0	1,444
24	595	1.0	1,440
28	594	1.0	1,421
Nov. 2	570	.9	1,298
7	535	.85	1,170
11	507	.8	1,074
15	509	.8	1,035
20	468	.7	985
24	457	.7	941
28	442	.6	849
Dec. 2	444	.55	850
7	460	.6	912
11	458	.6	890
16	445	.5	839
22	450	.6	871
28	438	.5	834

Daily gage height, in feet, of Rio Grande near Langtry, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.4	0.4	0.3	0.2	−0.05	3.2	2.55	4.0	2.5	2.65	1.0	0.5
2	.35	.4	.3	.15	− .05	3.0	2.7	4.05	2.5	2.45	.9	.55
3	.35	.4	.3	.15	− .05	3.1	2.75	4.35	2.55	2.25	.9	.6
4	.4	.4	.3	.15	.8	2.9	2.7	4.95	6.95	2.1	.9	.6
5	.4	.4	.3	.15	1.85	2.65	2.55	4.45	6.75	2.0	.85	.6
6	.45	.35	.3	.15	1.6	2.4	2.5	4.55	5.25	2.0	.85	.6
7	.5	.3	.3	.15	1.45	2.3	2.6	4.65	4.15	1.9	.85	.6
8	.45	.3	.25	.1	1.25	2.25	3.3	4.45	3.7	1.8	.8	.6
9	.35	.3	.25	.1	1.05	2.3	5.75	4.15	3.45	1.8	.8	.6
10	.35	.3	.25	.1	.95	2.3	6.55	3.7	3.25	1.7	.8	.6
11	.35	.3	.25	.05	.9	2.25	6.7	3.75	2.9	1.7	.8	.6
12	.35	.3	.25	.05	1.05	2.25	7.55	4.1	2.65	1.65	.8	.6
13	.4	.3	.25	.05	1.55	2.35	7.3	4.25	3.05	1.6	.8	.6
14	.4	.35	.25	.0	1.5	2.1	7.2	4.2	3.65	1.6	.8	.6
15	.4	.3	.25	.0	1.3	1.7	6.25	3.95	3.8	1.55	.8	.55
16	.4	.3	.25	.0	1.15	1.15	5.15	4.55	4.65	1.4	.75	.5
17	.4	.3	.25	.0	1.55	1.55	5.1	4.55	5.15	1.3	.7	.55
18	.4	.35	.25	.0	1.85	3.15	4.5	4.75	6.0	1.25	.7	.6
19	.4	.35	.25	.0	2.05	3.2	3.95	5.85	6.0	1.15	.7	.6
20	.4	.35	.25	.0	2.3	3.2	3.8	5.95	5.65	1.0	.7	.6
21	.4	.35	.2	− .05	2.5	3.4	3.65	5.8	5.3	1.0	.7	.6
22	.4	.3	.1	− .05	2.65	3.05	3.6	4.8	4.8	1.0	.7	.6
23	.4	.3	.1	− .05	2.85	3.1	3.7	4.15	4.15	1.0	.7	.6
24	.4	.3	.1	− .05	2.9	3.3	3.75	3.65	4.0	1.0	.7	.6
25	.4	.3	.1	− .05	3.05	3.5	3.5	3.3	3.9	1.0	.6	.6
26	.4	.3	.1	− .05	3.05	3.45	3.3	3.1	3.65	1.0	.55	.55
27	.4	.3	.1	− .05	3.1	3.15	3.45	3.1	3.4	1.0	.55	.55
28	.4	.35	.05	− .05	3.15	3.05	3.7	3.15	3.25	1.0	.55	.5
29	.4	......	.05	− .05	3.15	2.9	3.45	2.85	3.0	1.0	.55	.5
30	.4	......	.05	− .05	3.1	2.6	3.6	2.55	2.8	1.0	.5	.5
31	.4	......	.05	......	3.05	......	3.65	2.5	......	1.0	......	3.75

Daily discharge, in second-feet, of Rio Grande near Langtry, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	710	695	575	540	[a]380	4,780	3,580	6,950	3,360	3,850	1,400	810
2	[a]660	[a]685	[a]565	[a]510	380	[a]4,490	[a]3,860	7,060	[a]3,340	[a]3,280	[a]1,300	[a]850
3	660	685	565	510	380	4,710	3,950	[a]7,700	3,480	2,940	1,280	900
4	695	685	570	510	990	4,260	3,860	9,420	15,800	2,680	1,270	900
5	695	685	570	510	1,790	3,710	3,580	8,470	15,240	2,510	1,200	905
6	730	655	570	505	[a]1,600	[a]3,150	3,490	8,660	[a]11,030	2,510	1,180	905
7	[a]770	[a]630	[a]575	[a]505	1,480	2,950	3,680	[a]8,860	7,900	[a]2,330	[a]1,170	[a]910
8	730	630	550	485	1,320	2,880	[a]4,950	8,210	6,620	2,140	1,100	905
9	655	630	550	485	1,170	3,000	11,530	7,320	5,900	2,140	1,090	900
10	655	625	550	485	[a]1,090	[a]3,030	13,750	5,990	5,330	1,960	1,080	895
11	655	625	545	465	1,060	2,930	14,170	6,140	4,330	[a]1,960	[a]1,070	[a]890
12	[a]655	[a]625	545	[a]465	1,140	2,930	[a]16,510	[a]7,190	3,620	1,850	1,060	890
13	670	625	[a]545	465	1,410	3,120	15,800	7,690	[a]4,760	1,740	1,050	890
14	670	650	545	430	[a]1,380	2,640	15,520	7,520	6,410	1,710	1,040	890
15	670	630	545	425	1,180	[a]1,960	12,790	6,700	6,810	[a]1,650	[a]1,030	865
16	670	630	550	425	1,030	1,410	[a]9,650	[a]8,690	9,060	1,600	1,010	[a]840
17	670	[a]630	[a]550	[a]420	1,710	2,090	9,500	8,800	[a]10,380	1,560	985	855
18	[a]670	655	545	415	[a]2,220	4,830	7,990	9,320	12,880	1,540	985	870
19	675	655	535	410	2,600	[a]4,920	6,600	12,160	12,880	1,500	985	870
20	680	655	530	405	3,060	4,880	[a]6,200	12,410	11,850	[a]1,440	[a]985	870
21	685	[a]655	500	385	3,430	5,230	5,790	[a]12,030	[a]10,840	1,440	975	870
22	690	630	[a]445	[a]380	3,710	4,490	5,650	9,310	9,500	1,440	965	[a]870
23	[a]695	630	445	380	[a]4,100	[a]4,550	5,920	7,540	7,750	1,440	950	870
24	700	630	440	380	4,210	4,970	6,060	[a]6,150	7,350	[a]1,440	[a]940	870
25	705	[a]630	435	385	4,540	5,400	[a]5,370	5,150	[a]7,090	1,440	875	870
26	710	620	430	385	4,540	5,290	4,990	4,580	6,440	1,430	835	850
27	715	605	430	[a]385	4,650	[a]4,670	5,520	4,580	[a]5,780	1,430	825	850
28	[a]720	615	[a]415	385	[a]4,760	4,490	[a]6,300	[a]4,720	5,410	[a]1,420	[a]820	[a]835
29	715	......	420	390	4,760	4,220	5,760	4,080	4,780	1,420	830	835
30	705	......	425	390	4,660	3,680	6,080	3,480	4,280	1,410	805	835
31	700	......	430	......	4,560	......	6,190	3,380	......	1,400	......	7,100

[a] Date of measurement.

Monthly discharge of Rio Grande near Langtry, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	770	655	690	42,417
February	695	605	643	35,702
March	575	415	513	31,517
April	540	380	440	26,212
May	4,760	380	2,429	149,336
June	5,400	1,410	3,855	229,408
July	16,510	3,490	7,567	465,302
August	12,410	3,380	7,428	456,714
September	15,800	3,340	7,673	456,595
October	3,850	1,400	1,890	116,231
November	1,400	805	1,036	61,666
December	7,100	810	1,073	65,980
The year	16,510	380	2,936	2,137,080

RIO GRANDE BELOW DEVILS RIVER, TEX.

The station was established in April, 1900, by the International Boundary Commission. It is alongside the Southern Pacific Railroad track, about a mile below the mouth of Devils River and the town of Devils River, and about 480 miles below El Paso.

The bed of the river is rock for a short distance from the left bank; the right bank is alluvial deposit, overflowing in extreme high water for a distance of some 500 feet back from the river. The left bank is a loose rock fill, along which runs the Southern Pacific Railroad.

Frequent discharge measurements are made to determine closely the daily flow. The observations at this station during 1909 have been made under the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande below Devils River, Tex., in 1909.

[By E. E. Winter.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 5	905	3.7	1,592	July 15	2,499	7.5	16,198
10	918	3.7	1,619	19	2,091	6.0	9,212
15	924	3.7	1,729	23	5,221	14.6	42,532
21	934	3.7	1,789	27	1,700	5.5	6,623
26	948	3.7	1,770	31	2,055	6.2	9,476
31	938	3.7	1,734	Aug. 6	1,840	6.0	8,885
Feb. 5	919	3.6	1,686	11	1,635	5.6	7,115
10	928	3.6	1,690	15	1,662	5.7	7,486
15	911	3.6	1,655	20	2,212	7.0	13,065
20	911	3.6	1,645	23	1,755	6.0	8,875
24	901	3.6	1,604	27	1,542	5.3	6,231
28	1,006	3.75	1,879	31	1,328	4.8	4,574
Mar. 5	863	3.55	1,492	Sept. 5	1,347	5.1	5,363
10	858	3.55	1,469	9	1,730	5.7	7,771
15	866	3.55	1,433	16	1,851	6.05	9,588
20	836	3.5	1,359	20	2,060	6.55	12,012
26	833	3.5	1,330	24	1,740	5.9	8,453
31	829	3.45	1,282	26	1,681	5.65	7,243
Apr. 6	854	3.5	1,321	30	1,391	5.1	5,375
11	837	3.45	1,269	Oct. 6	1,195	4.5	3,602
16	826	3.4	1,193	10	1,112	4.3	2,943
20	828	3.4	1,156	14	1,102	4.3	2,939
25	829	3.4	1,175	19	1,031	4.0	2,342
30	856	3.5	1,302	23	1,067	4.0	2,355
May 5	871	3.55	1,393	27	1,066	4.0	2,347
9	1,062	4.0	2,272	31	1,072	4.0	2,304
13	1,082	4.0	2,229	Nov. 6	974	3.8	1,992
17	1,045	3.9	2,008	10	995	3.8	1,989
21	1,458	4.8	4,251	14	979	3.8	1,923
26	1,461	5.0	4,795	19	954	3.7	1,885
31	1,452	5.0	4,852	23	917	3.7	1,832
June 5	1,371	4.85	4,547	27	916	3.7	1,768
9	1,273	4.65	3,767	30	910	3.7	1,835
13	1,303	4.8	4,289	Dec. 4	926	3.7	1,694
18	1,395	5.0	4,741	9	915	3.7	1,692
22	1,358	5.0	4,901	14	912	3.7	1,677
26	1,560	5.3	6,166	18	934	3.7	1,687
30	1,321	4.9	4,694	24	939	3.8	1,709
July 7	1,341	4.8	4,607	30	957	3.7	1,716
11	2,511	7.8	16,693				

Daily gage height, in feet, of Rio Grande below Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.75	3.7	3.6	3.5	3.5	5.0	4.75	6.3	4.55	4.95	4.0	3.7
2	3.7	3.7	3.6	3.5	3.5	5.05	4.8	6.25	4.6	4.85	4.0	3.7
3	3.7	3.7	3.6	3.5	3.5	5.0	4.9	6.2	4.6	4.7	3.9	3.7
4	3.7	3.7	3.55	3.5	3.5	4.9	5.15	6.55	4.65	4.6	3.9	3.7
5	3.7	3.65	3.55	3.5	3.85	4.85	5.15	6.4	5.8	4.55	3.85	3.7
6	3.7	3.65	3.55	3.5	4.3	4.7	4.8	6.1	7.5	4.5	3.8	3.7
7	3.7	3.6	3.5	3.5	4.2	4.7	4.85	6.1	6.25	4.4	3.8	3.7
8	3.7	3.6	3.5	3.5	4.1	4.6	5.4	6.1	6.15	4.35	3.8	3.7
9	3.7	3.6	3.5	3.5	4.0	4.6	6.35	6.05	5.65	4.3	3.8	3.7
10	3.7	3.6	3.5	3.5	4.0	4.6	6.75	5.7	5.35	4.3	3.8	3.7
11	3.7	3.6	3.5	3.4	3.9	4.6	7.8	5.6	5.05	4.3	3.8	3.7
12	3.7	3.6	3.55	3.4	4.0	4.6	7.85	5.55	4.85	4.3	3.8	3.7
13	3.7	3.6	3.5	3.4	4.1	4.8	7.4	5.75	4.7	4.3	3.8	3.7
14	3.7	3.6	3.55	3.4	4.2	4.6	7.45	6.0	5.5	4.25	3.8	3.7
15	3.7	3.6	3.55	3.4	4.15	4.6	7.4	5.7	5.5	4.2	3.8	3.7

Daily gage height, in feet, of Rio Grande below Devils River, Tex., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	3.7	3.6	3.5	3.4	4.0	4.65	6.6	5.8	6.05	4.2	3.8	3.7
17	3.7	3.6	3.5	3.4	3.9	4.65	6.25	6.45	6.45	4.05	3.75	3.7
18	3.7	3.65	3.5	3.4	4.05	5.1	6.15	5.85	6.8	4.0	3.75	3.7
19	3.7	3.6	3.5	3.4	4.35	5.0	6.0	6.45	7.25	4.0	3.7	3.7
20	3.7	3.6	3.5	3.4	4.65	4.65	5.75	7.0	6.5	4.0	3.7	3.7
21	3.7	3.6	3.5	3.4	4.8	5.15	5.45	6.6	6.9	4.1	3.7	3.7
22	3.7	3.6	3.5	3.4	4.8	5.05	5.3	5.95	6.5	4.0	3.7	3.75
23	3.7	3.6	3.5	3.4	4.85	5.2	12.5	6.0	6.5	4.0	3.7	3.8
24	3.7	3.6	3.5	3.4	5.0	5.3	6.35	5.75	5.9	4.0	3.7	3.8
25	3.7	3.6	3.5	3.4	5.0	5.45	5.95	5.55	5.9	4.0	3.7	3.8
26	3.7	3.6	3.5	3.55	5.0	5.3	5.4	5.35	5.65	4.0	3.7	3.8
27	3.7	3.5	3.5	3.6	5.1	5.2	5.5	5.4	5.6	4.0	3.7	3.75
28	3.7	3.75	3.5	3.5	5.0	5.25	5.4	5.4	5.4	4.0	3.7	3.7
29	3.7	....	3.5	3.5	5.15	5.05	5.65	5.15	5.2	4.0	3.7	3.7
30	3.7	....	3.5	3.5	5.0	4.95	6.15	4.9	5.1	4.0	3.7	3.7
31	3.7	....	3.45	....	5.0	....	6.3	4.8	....	4.0	....	3.7

Daily discharge, in second-feet, of Rio Grande below Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,810	1,730	1,690	1,320	1,300	4,850	4,270	9,880	3,910	4,930	2,300	1,800
2	1,720	1,730	1,650	1,320	1,300	4,950	4,450	9,680	4,040	4,630	2,300	1,760
3	1,680	1,730	1,620	1,320	1,300	4,850	4,780	9,480	4,040	4,190	2,150	1,730
4	1,640	1,730	1,530	1,320	1,300	4,650	5,560	10,880	4,180	3,900	2,150	a1,690
5	a1,590	a1,700	a1,490	1,320	a1,980	a4,550	5,590	10,280	a8,510	3,750	2,070	1,690
6	1,600	1,700	1,490	a1,320	2,860	3,960	4,580	a9,330	16,200	a3,600	a1,990	1,690
7	1,600	1,690	1,440	1,320	2,670	3,960	a4,810	9,330	10,350	3,270	1,990	1,690
8	1,610	1,690	1,430	1,310	2,470	3,570	7,030	9,330	9,880	3,110	1,990	1,690
9	1,610	1,690	1,430	1,310	a2,270	a3,590	10,860	9,110	a7,600	2,940	1,990	a1,690
10	a1,620	a1,690	a1,420	1,300	2,260	3,590	12,470	7,560	6,550	a2,940	a1,990	1,690
11	1,640	1,690	1,420	a1,240	2,050	3,590	a16,690	a7,120	5,500	2,940	1,970	1,690
12	1,660	1,680	1,460	1,230	2,240	3,590	17,070	6,930	4,800	2,940	1,960	1,680
13	1,680	1,670	1,410	1,220	a2,450	a4,290	15,450	7,670	4,270	2,940	1,940	1,680
14	1,700	1,660	1,440	1,210	2,670	3,840	15,820	8,600	7,420	a2,840	a1,920	a1,680
15	a1,730	a1,660	a1,430	1,200	2,560	3,840	a15,730	a7,490	7,420	2,740	1,920	1,680
16	1,740	1,660	1,380	a1,190	2,230	3,950	12,000	7,910	a9,590	2,740	1,920	1,680
17	1,750	1,650	1,380	1,190	a2,010	3,950	10,370	10,700	11,530	2,440	1,900	1,690
18	1,760	1,700	1,370	1,180	2,380	a5,040	9,910	8,130	13,220	2,340	1,900	a1,690
19	1,770	1,650	1,370	1,170	3,150	4,780	a9,210	10,700	15,400	a2,340	a1,880	1,690
20	1,780	a1,640	a1,360	a1,160	3,870	3,770	8,240	a13,050	a11,790	2,340	1,870	1,690
21	a1,790	1,630	1,360	1,160	a4,250	5,310	7,080	11,380	13,590	2,540	1,850	1,690
22	1,780	1,620	1,350	1,160	4,250	a5,050	6,500	8,670	11,540	2,350	1,840	1,700
23	1,780	1,610	1,350	1,170	4,390	5,740	a34,260	a8,870	11,540	a2,350	a1,830	1,710
24	1,770	a1,600	1,340	1,170	4,800	6,170	9,980	7,930	a8,450	2,350	1,820	a1,710
25	1,770	1,600	1,340	a1,180	4,800	6,800	8,400	7,170	8,450	2,350	1,800	1,720
26	a1,770	1,600	a1,330	1,360	a4,800	a6,170	6,230	6,420	a7,240	2,350	1,780	1,730
27	1,770	1,500	1,330	1,430	5,070	5,800	a6,620	a6,560	7,070	a2,350	a1,770	1,710
28	1,760	a1,880	1,330	1,300	4,820	5,980	6,220	6,560	6,390	2,340	1,790	1,700
29	1,750	....	1,320	1,300	5,220	5,250	7,230	5,730	5,710	2,330	1,810	1,710
30	1,740	....	1,320	a1,300	4,840	a4,880	9,270	4,900	5,370	2,320	a1,830	a1,720
31	a1,730	....	a1,280	....	a4,850	....	a9,880	a4,570	....	a2,300	....	1,720

a Date of measurement.

Monthly discharge of Rio Grande below Devils River, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	1,810	1,590	1,713	105,322
February	1,880	1,500	1,671	92,787
March	1,690	1,280	1,415	86,995
April	1,430	1,160	1,256	74,737
May	5,220	1,300	3,142	193,210
June	6,800	3,570	4,677	278,301
July	34,260	4,270	9,889	608,053
August	13,050	4,570	8,449	519,511
September	16,200	3,910	8,385	498,942
October	4,930	2,300	2,896	178,096
November	2,300	1,770	1,941	115,478
December	1,800	1,680	1,703	104,707
The year	34,260	1,160	3,928	2,856,139

RIO GRANDE AT EAGLE PASS, TEX.

The station was established in April, 1900, by the International Boundary Commission. It is one-half mile above the highway bridge between Eagle Pass, Tex., and Ciudad Porfirio Diaz, Mexico, and about 540 miles below El Paso.

The right bank is alluvial deposit, with a bottom back of it about 1,500 feet wide, which begins to overflow at gage height 22 feet. The left bank is shale rock rising abruptly from the river. The bed of the stream is constantly shifting, and frequent discharge measurements are necessary to determine closely the daily discharge. The section is subject to overflow at high stages. At low water, the depth is considerable and the velocity slow.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Rio Grande at Eagle Pass, Tex., in 1909.

[By J. K. Wilson.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	1,271	1.4	2,232	Mar. 9	1,076	1.1	1,768
6	1,296	1.4	2,252	12	1,250	1.4	2,274
9	1,275	1.4	2,240	16	1,099	1.1	1,843
12	1,337	1.4	2,316	19	1,065	1.0	1,748
16	1,346	1.4	2,351	22	1,046	1.0	1,665
18	1,252	1.4	2,236	25	1,112	1.1	1,873
21	1,228	1.4	2,195	28	1,084	.9	1,680
24	1,245	1.4	2,167	31	1,050	.9	1,727
27	1,243	1.4	2,191	Apr. 3	1,032	.9	1,670
31	1,235	1.4	2,144	6	1,043	.9	1,739
Feb. 3	1,232	1.4	2,181	9	1,027	.9	1,651
6	1,229	1.4	2,150	12	1,001	.8	1,536
9	1,202	1.3	2,102	16	994	.8	1,538
12	1,189	1.3	2,071	19	1,016	.8	1,538
16	1,194	1.4	2,040	22	1,005	.8	1,531
19	1,181	1.2	2,037	25	963	.8	1,458
22	1,178	1.2	2,030	28	1,396	1.8	2,545
25	1,136	1.2	1,904	30	1,012	.9	1,642
28	1,128	1.2	1,882	May 3	975	.7	1,488
Mar. 3	1,120	1.2	1,882	6	930	.7	1,413
6	1,079	1.1	1,784	9	1,315	1.6	2,204

Discharge measurements of Rio Grande at Eagle Pass, Tex., in 1909—Continued.

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 13	1,313	1.6	2,294	Sept. 7	2,491	4.5	11,873
16	1,294	1.5	2,126	10	2,018	3.6	7,836
19	1,285	1.5	2,336	13	1,924	2.8	6,122
22	1,677	2.7	4,601	16	1,919	3.4	7,121
25	1,679	2.8	4,439	19	2,562	4.3	8,571
28	1,787	3.0	5,295	22	2,785	5.05	14,533
31	1,760	2.9	5,261	25	2,180	4.0	8,872
June 3	1,814	3.15	5,346	28	2,186	3.5	8,469
6	1,724	2.8	4,648	30	1,983	3.0	6,414
9	1,806	2.3	4,902	Oct. 3	1,836	2.6	5,800
12	1,809	2.2	4,871	6	1,771	2.4	5,179
15	1,859	2.55	5,500	10	1,336	2.0	2,861
18	1,716	2.2	3,421	13	1,327	2.0	2,745
21	1,943	2.85	6,011	16	1,288	2.0	2,678
24	2,067	3.1	7,044	19	1,258	1.7	2,608
27	2,144	3.2	7,428	22	1,248	1.6	2,571
30	2,046	3.0	6,625	25	1,288	1.5	2,644
July 3	1,909	2.8	6,096	28	1,253	1.5	2,594
6	1,860	3.0	5,744	31	1,266	1.5	2,592
9	1,935	3.15	5,959	Nov. 3	1,237	1.5	2,493
12	2,818	5.3	14,831	6	1,226	1.4	2,393
16	2,865	5.4	14,977	9	1,195	1.3	2,321
18	2,502	4.4	11,401	12	1,194	1.3	2,344
21	2,405	3.7	7,120	15	1,250	1.3	2,378
24	4,955	8.35	27,644	18	1,213	1.4	2,340
27	2,147	3.4	5,518	21	1,229	1.4	2,327
31	2,546	4.0	8,275	24	1,177	1.4	2,188
Aug. 3	2,730	4.4	12,644	27	1,111	1.4	2,069
6	2,423	4.35	11,106	30	1,086	1.4	1,913
9	2,657	4.3	8,639	Dec. 3	1,082	1.4	1,964
13	2,125	3.7	9,106	6	1,044	1.3	1,747
16	2,094	3.8	8,517	9	1,122	1.2	1,862
19	2,135	3.9	8,921	13	1,139	1.2	1,981
22	2,684	4.9	13,329	16	1,172	1.2	2,040
25	2,086	3.75	8,502	22	1,173	1.2	2,069
28	1,829	3.3	6,160	25	1,202	1.2	2,052
31	1,931	2.7	5,781	28	1,159	1.2	2,019
Sept. 3	1,751	2.7	4,650	31	1,164	1.2	2,000

Daily gage height, in feet, of Rio Grande at Eagle Pass, Tex., for 1909.

Day.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.4	1.4	1.2	0.9	0.9	2.9	2.9	4.6	2.45	3.0	1.5	1.4
2	1.4	1.4	1.2	.9	.7	3.1	2.8	4.4	2.4	2.6	1.5	1.4
3	1.4	1.4	1.2	.9	.7	3.15	2.8	4.3	2.6	2.6	1.5	1.4
4	1.4	1.4	1.2	.9	.7	2.9	2.9	4.3	2.55	2.55	1.5	1.35
5	1.4	1.4	1.1	.9	.7	2.95	2.9	4.8	4.25	2.45	1.4	1.35
6	1.4	1.4	1.1	.9	1.1	2.8	3.0	4.3	5.35	2.4	1.4	1.3
7	1.4	1.4	1.1	.9	1.9	2.4	3.7	4.0	4.4	2.35	1.3	1.3
8	1.4	1.35	1.1	.9	1.75	2.3	3.05	4.35	4.0	2.25	1.3	1.2
9	1.4	1.3	1.1	.9	1.55	2.25	3.1	4.25	3.5	2.2	1.3	1.2
10	1.4	1.3	1.1	.9	1.4	2.25	4.5	3.85	3.5	2.0	1.3	1.2
11	1.4	1.3	1.25	.9	1.4	2.2	5.45	3.65	3.25	2.0	1.3	1.2
12	1.4	1.3	1.4	.8	1.4	2.2	5.3	3.45	2.8	2.0	1.3	1.2
13	1.4	1.3	1.35	.8	1.6	2.2	5.35	3.75	2.7	2.0	1.35	1.2
14	1.4	1.4	1.3	.8	1.6	2.65	5.3	3.9	2.7	2.0	1.3	1.2
15	1.4	1.4	1.25	.8	1.55	2.45	5.6	4.0	5.55	2.0	1.3	1.2
16	1.4	1.35	1.1	.8	1.5	2.0	5.4	3.85	3.1	2.0	1.35	1.2
17	1.4	1.3	1.0	.8	1.5	2.1	4.7	4.1	4.1	1.7	1.4	1.2
18	1.4	1.25	1.0	.8	1.45	2.2	4.4	4.0	4.5	1.7	1.4	1.2
19	1.4	1.2	1.0	.8	1.55	2.7	4.3	4.0	4.5	1.7	1.4	1.2
20	1.4	1.2	1.05	.8	1.95	2.75	4.0	4.65	5.2	1.7	1.5	1.2
21	1.4	1.2	1.0	.8	2.35	2.95	3.7	4.9	4.35	1.65	1.4	1.2
22	1.4	1.2	1.0	.8	2.65	2.85	3.4	4.9	5.0	1.6	1.4	1.2
23	1.4	1.2	1.0	.8	2.7	2.95	5.9	4.2	4.8	1.5	1.4	1.2
24	1.4	1.2	1.4	.8	2.85	3.1	8.0	3.85	4.25	1.5	1.4	1.2
25	1.4	1.2	1.15	.8	2.8	3.4	4.5	3.65	4.0	1.5	1.4	1.2
26	1.4	1.2	1.05	.8	2.95	3.25	4.0	3.4	3.85	1.5	1.4	1.2
27	1.4	1.2	.95	1.55	2.9	3.2	3.4	3.15	3.6	1.5	1.4	1.2
28	1.4	1.2	.9	1.65	2.95	3.0	3.55	3.35	3.45	1.5	1.4	1.2
29	1.4	......	.9	.9	2.9	3.05	3.6	3.2	3.35	1.5	1.4	1.2
30	1.4	......	.9	.9	2.95	2.95	3.5	2.9	3.0	1.5	1.4	1.2
31	1.4	......	.9	......	2.9	......	4.3	2.65	......	1.5	......	1.2

Daily discharge, in second-feet, of Rio Grande at Eagle Pass, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,190	2,160	1,880	1,710	1,640	5,260	6,360	12,070	4,780	6,410	2,560	1,930
2	2,210	2,170	1,880	1,690	1,490	5,330	6,100	11,860	4,580	5,800	2,530	1,950
3	[a]2,230	[a]2,180	[a]1,880	[a]1,670	[a]1,490	[a]5,350	[a]6,100	[a]12,340	[a]4,450	[a]5,800	[a]2,490	[a]1,960
4	2,240	2,170	1,880	1,690	1,460	4,850	6,040	12,340	4,350	5,640	2,490	1,870
5	2,240	2,160	1,780	1,720	1,440	4,950	5,790	13,840	10,900	5,330	2,390	1,840
6	[a]2,250	[a]2,150	[a]1,780	[a]1,740	[a]1,760	[a]4,650	[a]5,740	[a]10,860	15,700	[a]5,180	[a]2,390	[a]1,750
7	2,250	2,150	1,780	1,710	2,470	4,500	7,840	8,620	[a]11,420	4,750	2,320	1,820
8	2,250	2,120	1,770	1,680	2,340	4,650	5,610	9,630	9,630	4,170	2,320	1,790
9	[a]2,240	[a]2,100	[a]1,770	[a]1,650	[a]2,160	[a]4,890	[a]5,780	[a]8,490	7,380	3,740	[a]2,320	[a]1,860
10	2,260	2,090	1,840	1,640	2,070	4,890	11,520	7,860	[a]7,620	[a]2,860	2,330	1,890
11	2,290	2,080	2,060	1,630	2,090	4,870	15,440	7,820	7,090	2,820	2,340	1,920
12	[a]2,320	[a]2,070	[a]2,270	[a]1,540	2,110	[a]4,870	[a]14,830	7,790	6,120	2,780	[a]2,340	1,950
13	2,330	2,040	2,190	1,540	[a]2,290	4,870	15,030	[a]9,260	[a]5,920	[a]2,740	2,400	[a]1,980
14	2,340	2,100	2,110	1,540	2,290	5,680	14,830	9,410	5,920	2,720	2,370	2,000
15	2,350	2,070	2,020	1,540	2,210	[a]5,300	16,030	9,410	16,500	2,700	[a]2,380	2,020
16	[a]2,350	[a]1,990	[a]1,840	[a]1,540	[a]2,130	3,940	[a]14,980	[a]8,660	[a]6,640	[a]2,680	2,380	[a]2,040
17	2,290	2,010	1,750	1,540	2,200	3,680	12,480	9,730	8,250	2,610	2,380	2,040
18	[a]2,240	2,020	1,750	1,540	2,220	[a]3,420	[a]11,400	9,320	8,890	2,610	[a]2,340	2,050
19	2,220	[a]2,040	[a]1,750	[a]1,540	[a]2,430	5,410	10,790	[a]9,320	[a]9,370	2,610	2,340	2,050
20	2,210	2,040	1,770	1,540	3,190	5,610	8,950	12,230	13,160	2,610	2,430	2,060
21	[a]2,190	2,030	1,690	1,530	3,940	[a]6,420	[a]7,120	13,330	10,740	2,590	[a]2,330	2,060
22	2,180	[a]2,030	[a]1,660	[a]1,530	[a]4,510	6,010	5,790	[a]13,330	[a]14,260	[a]2,570	2,280	[a]2,070
23	2,170	1,990	1,660	1,510	4,490	6,420	16,830	10,390	13,180	2,570	2,230	2,060
24	[a]2,170	1,950	2,060	1,480	4,640	[a]7,040	[a]26,100	8,920	10,220	2,610	[a]2,190	2,060
25	2,170	[a]1,910	[a]1,910	[a]1,460	[a]4,440	8,200	10,430	[a]8,100	[a]8,870	[a]2,640	2,150	[a]2,050
26	2,180	1,900	1,820	1,460	4,870	7,620	8,200	7,100	8,750	2,630	2,120	2,040
27	[a]2,190	1,890	1,720	2,280	4,940	[a]7,430	[a]5,520	6,100	8,550	2,610	[a]2,090	2,030
28	2,180	[a]1,880	[a]1,680	[a]2,390	[a]5,200	6,630	6,210	[a]6,260	[a]8,260	[a]2,590	2,030	[a]2,020
29	2,170	....	1,690	1,640	5,260	6,830	6,440	6,100	7,850	2,590	1,970	2,010
30	2,160	....	1,710	1,640	5,280	[a]6,490	[a]5,980	5,910	[a]6,410	2,590	[a]1,910	2,010
31	[a]2,150	....	[a]1,730	....	[a]5,260	....	[a]9,780	[a]5,700	....	[a]2,590	....	[a]2,000

[a] Date of measurement.

Monthly discharge of Rio Grande at Eagle Pass, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	2,350	2,150	2,233	137,276
February	2,180	1,880	2,053	114,030
March	2,270	1,660	1,841	113,217
April	2,390	1,460	1,644	97,805
May	5,280	1,440	3,042	187,061
June	8,200	3,420	5,535	329,375
July	26,100	5,520	10,001	614,955
August	13,840	5,700	9,423	579,372
September	16,500	4,350	8,859	527,127
October	6,410	2,570	3,392	208,542
November	2,560	1,910	2,305	137,137
December	2,070	1,750	1,974	121,349
The year	26,100	1,440	4,358	3,167,246

RIO GRANDE NEAR LAREDO, TEX.

The station was established near Nuevo Laredo, Mexico, in April, 1900, by the International Boundary Commission. It was intended to measure the river from the highway bridge connecting Laredo, Tex., with Nuevo Laredo, Tamaulipas, and the gage was established on the right bank just above the bridge. Measurements were kept up by the Mexican section of the commission until September 24, 1900, and gage heights were read until February 28, 1903, but the results were so conflicting that the station was abandoned. In July, 1903, a cable station was established by the commission about 2 miles above Nuevo Laredo, and on August 1, 1903, regular meter measurements and gage heights were started. The new gage heights are not comparable with the old. The station is about 670 miles below El Paso.

The river bed at the new station is constantly shifting, and frequent discharge measurements are made to determine closely the daily discharge. The banks at the new station are not subject to overflow.

The observations at these stations have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Grande near Laredo, Tex., in 1909.

[By L. Varela.]

Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*
Jan. 6	1,424	2.5	2,333
10	1,438	2.6	2,388
16	1,531	2.8	2,845
21	1,419	2.4	2,328
26	1,340	2.0	1,933
31	1,440	2.5	2,229
Feb. 5	1,389	2.3	2,167
9	1,464	2.5	2,349
14	1,453	2.5	2,308
20	1,441	2.2	2,239
25	1,418	2.1	2,232
Mar. 1	1,288	2.0	1,950
5	1,500	2.4	2,316
10	1,453	2.2	2,284
13	2,409	4.4	6,598
18	1,260	2.0	1,731
26	1,472	2.2	2,278
31	1,285	2.1	1,817
Apr 5	1,324	2.2	2,001
12	1,468	2.3	2,258
16	1,306	2.1	1,857
21	1,342	2.1	1,887
25	1,341	2.0	1,843
30	1,403	2.3	2,148
May 6	1,294	2.0	1,833
11	1,390	2.3	2,065
15	1,414	2.5	2,144
22	2,449	4.6	6,752
27	2,816	5.6	9,691
31	2,543	4.5	5,997
June 6	1,787	4.0	3,756
11	1,602	3.4	3,281
16	1,399	2.5	2,116
21	1,358	2.6	2,272
25	1,576	3.5	3,266
30	1,281	3.0	2,620
July 7	1,640	4.2	3,692
7	2,921	6.5	13,373
July 12	1,751	4.7	4,403
16	3,397	7.0	18,433
23	1,623	4.0	3,789
24	4,004	8.8	29,931
25	3,809	8.1	21,319
31	1,637	3.0	3,335
Aug. 3	1,676	4.4	4,020
9	1,766	4.3	3,873
14	1,716	4.3	3,827
19	1,545	3.5	3,210
22	1,883	5.1	6,270
29	2,026	5.6	7,138
Sept. 3	1,432	3.3	2,809
7	1,869	6.5	8,312
14	1,571	3.7	3,497
16	2,104	6.7	9,768
21	2,642	6.3	11,758
27	2,307	5.8	8,078
30	1,937	4.9	5,776
Oct. 5	1,842	4.0	4,310
10	1,637	3.7	3,349
15	1,558	3.2	2,951
21	1,432	3.0	2,584
26	1,414	2.8	2,271
31	1,376	2.8	2,286
Nov. 5	1,349	2.7	2,036
11	1,323	2.6	1,983
17	1,334	2.5	2,024
21	1,442	2.4	2,151
26	1,427	2.4	2,055
30	1,383	2.35	2,028
Dec. 5	1,323	2.4	1,992
11	1,285	2.3	1,836
16	1,265	2.3	1,745
21	1,297	2.5	2,006
27	1,317	2.5	2,007
31	1,291	2.5	2,006

Daily gage height, in feet, of Rio Grande near Laredo, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	2.5	2.0	2.2	2.2	4.5	2.8	3.1	3.6	4.6	2.7	2.35
2	2.55	2.6	2.1	2.2	2.1	5.45	2.8	3.75	3.4	4.7	2.55	2.4
3	2.5	2.5	2.1	2.15	2.05	4.6	2.5	4.3	3.4	4.4	2.5	2.4
4	2.5	2.4	2.3	2.1	2.0	4.75	2.8	3.6	3.6	4.05	2.7	2.4
5	2.4	2.3	2.4	2.2	2.0	4.1	3.15	3.95	3.3	3.95	2.7	2.4
6	2.45	2.3	2.3	2.2	2.0	4.1	3.7	4.55	3.9	3.9	2.6	2.3
7	2.5	2.3	2.3	2.15	2.0	4.1	4.95	4.3	6.05	3.55	2.5	2.3
8	2.4	2.4	2.15	2.15	2.1	3.7	5.4	3.7	5.6	3.45	2.4	2.3
9	2.45	2.5	2.1	2.2	2.2	3.5	3.65	4.4	5.0	3.6	2.5	2.25
10	2.6	2.5	2.2	2.2	2.3	3.4	3.1	4.1	4.6	3.7	2.6	2.2
11	2.6	2.45	2.2	2.1	2.3	3.4	4.1	3.6	4.3	3.6	2.55	2.3
12	2.5	2.3	2.5	2.2	2.2	2.95	5.0	3.85	4.3	3.9	2.45	2.3
13	2.4	2.3	4.45	2.3	2.2	2.65	5.7	3.45	4.1	3.7	2.2	2.3
14	2.6	2.45	3.3	2.3	2.1	2.5	6.65	4.15	3.85	3.4	2.1	2.3
15	2.75	2.3	2.45	2.2	2.5	2.5	5.6	3.2	5.85	3.35	2.3	2.3
16	2.8	2.3	2.2	2.1	2.4	2.5	7.15	3.35	6.5	3.35	2.35	2.3
17	2.75	2.4	2.05	2.1	2.5	2.4	5.9	3.8	5.0	3.2	2.45	2.3
18	2.65	2.3	2.0	2.2	2.6	2.4	5.05	3.4	5.5	3.75	2.4	2.3
19	2.6	2.2	2.1	2.2	2.75	2.2	5.15	3.55	5.8	3.7	2.4	2.3
20	2.4	2.2	2.1	2.1	2.4	2.45	5.6	3.45	6.4	3.2	2.4	2.45
21	2.4	2.15	2.1	2.1	3.5	2.55	4.85	3.75	6.15	3.0	2.4	2.5
22	2.3	2.1	2.1	2.1	4.3	2.4	4.25	5.25	5.6	2.95	2.4	2.5
23	2.3	2.2	2.25	2.1	3.25	2.75	4.15	5.0	4.8	2.6	2.4	2.5
24	2.2	2.1	2.6	2.0	3.25	2.8	9.2	4.3	5.15	2.9	2.4	2.5
25	2.15	2.1	2.35	2.0	3.2	3.25	6.65	3.85	4.3	2.95	2.4	2.5
26	2.0	2.05	2.2	2.0	4.25	3.15	4.4	4.5	4.9	2.8	2.4	2.5
27	2.0	2.0	2.2	2.0	5.4	3.25	3.5	4.5	5.65	2.45	2.4	2.5
28	2.0	2.0	2.2	2.05	4.45	3.3	2.75	4.8	5.6	2.2	2.4	2.5
29	2.1	....	2.15	2.25	4.0	3.2	2.85	5.45	5.15	2.65	2.4	2.5
30	2.35	....	2.1	2.25	4.0	3.0	2.55	4.85	4.9	2.8	2.35	2.5
31	2.5	....	2.1	....	4.1	....	2.85	4.4	....	2.8	....	2.5

RIO GRANDE NEAR ROMA, TEX.

The station was established in 1900 by the International Boundary Commission. It is near Roma, Tex., 775 miles, by river, below El Paso.

The right bank is alluvial deposit, and overflows in high water for a width of 250 feet. The overflow section is thickly covered with mesquite brush. The left bank is of hard material, and does not overflow.

The river bed is constantly shifting, and frequent discharge measurements are necessary to determine closely the daily discharge. The section is subject to overflow at high water.

The highest recorded flood, September 16, 1904, marked 26 feet on the gage.

The observations at this section have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Grande near Roma, Tex., in 1909.

[By H. P. Guerra.]

Date.	Area of section.	Gage height.	Discharge	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	1,486	2.9	2,286	July 2	5,745	12.7	32,157
6	1,349	2.8	2,101	6	8,502	18.3	53,442
10	1,357	2.8	2,068	10	3,945	8.4	18,380
14	1,357	2.8	2,097	14	4,242	9.1	19,390
18	1,314	2.7	2,008	18	4,068	8.7	18,841
22	1,319	2.7	2,010	22	3,849	8.2	17,394
26	1,317	2.7	2,021	25	4,594	10.2	22,162
30	1,317	2.5	2,020	30	3,099	6.6	11,482
Feb. 2	1,290	2.5	1,954	Aug. 2	3,102	6.6	11,493
6	1,202	2.4	1,862	6	3,194	6.8	12,435
10	1,204	2.4	1,851	10	3,535	7.6	16,066
14	1,206	2.4	1,857	13	4,320	9.4	19,870
18	1,117	2.0	1,721	17	3,580	7.6	16,198
23	1,121	2.0	1,729	22	3,112	6.6	11,840
27	1,119	2.0	1,726	26	3,112	6.6	11,854
Mar. 2	1,039	1.9	1,600	28	6,079	13.2	33,246
6	1,042	1.9	1,605	30	8,959	19.0	59,129
10	1,044	1.9	1,608	Sept. 2	5,326	11.6	26,809
14	2,053	4.3	3,372	6	3,553	7.6	16,168
18	1,118	2.0	1,701	10	3,408	7.3	15,007
22	1,116	2.0	1,707	14	3,061	6.4	10,838
26	1,276	2.5	1,918	18	3,063	6.4	10,859
30	1,044	1.9	1,618	22	3,758	8.0	16,921
Apr. 2	1,036	1.9	1,600	26	3,554	7.6	16,249
6	948	1.7	1,444	29	3,553	6.4	10,808
8	2,027	4.3	3,400	Oct. 2	3,013	6.3	10,665
12	1,281	2.5	1,934	6	2,350	4.9	5,013
17	949	1.7	1,458	10	2,204	4.5	4,151
22	845	1.0	1,184	14	2,028	4.0	3,230
26	841	1.0	1,177	18	1,922	3.8	3,049
29	841	1.0	1,186	22	1,950	3.9	3,160
May 2	1,269	2.5	1,924	26	1,897	3.7	3,005
6	847	1.0	1,215	30	1,549	3.0	2,444
10	851	1.0	1,221	Nov. 2	1,553	3.0	2,457
12	1,287	2.5	1,996	6	1,425	2.8	2,236
17	974	1.8	1,534	10	1,436	2.8	2,269
21	1,227	2.4	1,900	14	1,848	3.7	3,011
22	2,028	4.0	3,214	18	1,852	3.7	3,013
25	2,067	4.3	3,441	22	1,634	3.4	2,719
27	2,376	5.0	5,286	26	1,637	3.4	2,724
28	3,634	7.7	16,337	29	1,644	3.5	2,736
June 2	4,410	9.8	20,467	Dec. 2	1,644	3.5	2,738
6	2,147	4.4	3,731	6	1,640	3.5	2,734
10	1,704	3.7	3,011	10	1,644	3.5	2,739
14	1,673	3.4	2,794	14	1,486	3.4	2,637
18	1,625	3.3	2,698	18	1,494	3.4	2,666
22	2,113	4.3	3,605	22	1,490	3.4	2,662
26	2,421	5.4	6,604	26	1,517	3.7	2,905
29	2,468	5.4	6,929	30	1,525	3.7	2,953

Daily gage height, in feet, of Rio Grande near Roma, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.9	2.5	2.0	1.9	1.5	5.0	7.9	6.35	15.95	6.2	3.0	3.5
2	2.9	2.5	1.9	1.9	2.15	9.6	13.3	6.6	13.55	6.05	3.1	3.5
3	2.9	2.5	1.9	1.7	1.6	6.55	18.7	7.3	11.15	5.7	3.05	3.5
4	2.9	2.5	1.9	1.7	1.15	4.4	18.65	6.95	8.4	5.6	3.0	3.5
5	2.8	2.5	1.9	1.75	1.0	4.4	18.65	6.8	7.6	5.2	3.0	3.4
6	2.8	2.4	1.9	1.8	0.9	4.4	18.3	7.0	7.7	4.9	2.85	3.4
7	2.8	2.4	1.9	1.7	.9	4.25	14.4	7.5	8.95	4.8	2.85	3.5
8	2.8	2.4	1.9	4.05	.8	4.15	10.3	7.85	9.35	4.65	3.1	3.5
9	2.8	2.4	1.9	2.85	.8	4.0	9.35	7.65	8.55	4.5	3.6	3.5
10	2.8	2.4	1.9	2.45	.85	3.8	8.1	7.4	7.4	4.45	2.9	3.5
11	2.8	2.4	1.9	2.55	2.3	3.85	7.25	7.05	7.25	4.35	3.15	3.4
12	2.8	2.4	1.9	2.1	2.35	3.8	8.2	8.2	7.1	4.25	3.7	3.4
13	2.8	2.4	1.9	1.85	2.15	3.7	8.8	8.95	6.8	4.15	3.7	3.4
14	2.75	2.35	3.1	1.75	2.0	3.45	9.15	7.25	6.35	4.05	3.7	3.4
15	2.7	2.25	3.5	1.55	1.9	3.4	8.95	7.0	6.65	4.0	3.65	3.4
16	2.7	2.1	3.05	1.35	1.8	3.4	8.8	6.85	6.5	3.9	3.6	3.4
17	2.7	2.05	2.4	1.1	1.8	3.4	9.15	6.7	6.55	3.9	3.6	3.4
18	2.7	2.0	2.1	1.0	1.95	3.3	8.5	6.95	6.7	3.8	3.6	3.4
19	2.7	2.0	1.95	1.0	2.2	3.3	7.9	6.95	8.0	4.3	3.6	3.4
20	2.7	2.0	1.9	1.0	2.5	3.4	9.15	6.75	7.85	5.1	3.6	3.4
21	2.7	2.0	1.9	1.0	2.45	3.5	8.8	6.65	8.0	3.9	3.5	3.4
22	2.7	2.0	1.95	1.0	3.95	4.1	7.75	6.6	7.95	3.85	3.4	3.4
23	2.7	2.0	1.8	1.0	4.0	4.3	7.1	7.35	7.75	3.75	3.4	3.8
24	2.7	2.0	1.7	1.0	3.65	4.75	6.8	7.15	7.75	3.7	3.4	3.85
25	2.7	2.0	1.95	1.0	4.0	4.9	9.5	6.8	7.65	3.7	3.4	3.7
26	2.65	2.0	2.3	1.0	4.9	5.3	8.2	6.55	7.5	3.65	3.4	3.7
27	2.55	2.0	1.9	1.0	6.25	5.45	7.2	8.7	6.9	3.5	3.5	3.7
28	2.5	2.0	2.65	1.0	7.7	5.4	6.7	12.75	6.7	3.35	3.5	3.7
29	2.5	....	2.05	1.0	5.5	5.4	6.65	16.95	6.5	3.3	3.5	3.7
30	2.5	....	1.85	1.0	5.25	5.4	6.5	18.95	6.35	3.15	3.5	3.7
31	2.5	....	1.8	....	4.9	....	6.35	17.05	....	3.0	....	3.7

RIO GRANDE NEAR BROWNSVILLE, TEX.

This station was established in 1900 by the International Boundary Commission. It is about one mile above Brownsville, Tex., and opposite Matamoros, Tamaulipas, Mex., and 900 miles by river below El Paso.

Between Roma and Brownsville there are many lagoons (old river beds) which take river water during moderate floods, and a large area overflows quite deeply in larger floods. Much of this water returns slowly to the river as the flood subsides, so that the flow passes Brownsville more uniformly than it does Roma. Large quantities of water also leave the river entirely, reaching the Gulf of Mexico through channels remote from the Rio Grande. Local run-off, however, keeps the total water at Brownsville well up toward the combined flow of the San Juan and the Rio Grande at Roma. Both banks are alluvial and are just about level with high water. The right bank is protected by piling.

As the bed of the river is constantly shifting, frequent discharge measurements are made to determine closely the daily flow.

The observations at this station have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Grande near Brownsville, Tex., in 1909.

[By P. Guerra.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	1,492	1.5	1,825	July 3	4,946	12.4	25,488
7	1,488	1.5	1,815	7	5,514	13.4	28,999
11	1,494	1.5	1,831	11	5,612	13.8	30.235
15	1.480	1.4	1,789	15	4,739	11.4	17,249
19	1,488	1.4	1,815	19	4,633	11.1	16.282
23	1,478	1.3	1,790	23	3,853	8.9	11,847
27	1,478	1.3	1,782	27	4,909	12.3	23,385
31	1,474	1.2	1,756	31	2,871	7.0	8,549
Feb. 3	1,468	1.1	1,741	Aug. 3	2.822	6.7	8,219
7	1,464	1.1	1,722	7	3,354	8.1	10,373
11	1,460	1.1	1,715	11	3,500	8.6	11,331
15	1,289	.9	1,414	15	5,388	13.8	27,687
19	1,271	.5	1,404	19	3,855	9.5	12,782
23	1,261	.4	1,379	23	3,627	8.8	11,943
27	1,240	.3	1,340	27	4,870	12.0	21,087
Mar. 3	1,226	.2	1,314	31	5,512	13.9	29,543
7	1,206	.1	1,270	Sept. 3	5,550	14.0	30,188
11	1,216	.1	1,267	7	5,660	14.3	31,655
15	1,198	.0	1,228	11	5,402	13.6	28,331
19	1,484	1.0	1.697	15	4,542	11.2	18,707
23	1,282	.4	1,383	19	5,478	13.8	28,921
27	1,264	.2	1.354	23	5,112	12.8	25,470
30	1,180	- .1	1,227	26	5.364	13.5	27,742
Apr. 2	1,083	- .2	1,133	30	4,266	10.4	16,959
6	1,047	- .4	1,077	Oct. 3	4,039	9.2	12,195
10	1,103	- .2	1,192	7	3,698	8.0	10,396
14	1,784	2.0	2,759	11	3,491	7.4	7,839
18	1,425	.7	1,717	15	3,164	6.8	6,183
22	1,049	- .4	1.068	19	2,892	6.0	5,431
26	973	- .8	954	23	3,017	6.4	5.731
30	973	- .8	943	27	2,716	5.3	5,004
May 2	947	- .9	890	30	2,529	4.7	4,569
6	1,055	- .4	1.086	Nov. 3	2,403	4.4	4,820
10	1,034	- .7	1,036	7	2,292	4.1	4,357
14	1,066	- .6	1,089	11	2,256	4.0	4,229
18	1,264	.2	1,365	15	2,226	3.9	4,087
22	1,276	.3	1,386	19	2,044	3.3	3,731
26	1,840	2.6	2.983	23	1,992	3.1	3,574
30	3,750	9.2	10,959	28	1,936	2.9	3.396
June 3	3,416	8.2	9,643	Dec. 2	1,912	2.8	3.254
7	2,489	5.0	4,656	6	1,980	3.0	3,542
11	2,225	4.1	4.169	10	1,882	2.7	3,132
14	1,912	3.0	3,525	14	1,838	2.5	2,936
18	1,849	2.8	3,335	18	1,846	2.5	2,939
22	1,771	2.4	3,118	22	1,856	2.6	3,010
26	1,836	2.7	3,280	26	1,926	2.8	3.191
30	2,331	4.4	4,529	30	1,964	2.9	3,399

Daily gage height, in feet, of Rio Grande near Brownsville, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	1.1	0.3	-0.1	-0.8	6.35	6.3	6.6	14.0	9.8	4.5	2.85
2	1.5	1.1	.3	- .2	- .9	5.4	8.8	6.6	14.0	9.45	4.45	2.8
3	1.5	1.1	.2	- .2	- .75	7.6	11.85	6.75	14.0	9.25	4.4	2.75
4	1.5	1.1	.2	- .3	- .55	10.1	13.05	7.2	14.2	8.9	4.3	2.7
5	1.5	1.1	.2	- .4	- .4	9.3	13.2	8.0	14.2	8.65	4.2	2.7
6	1.5	1.1	.1	- .4	- .3	7.85	13.25	8.3	14.2	8.4	4.2	2.9
7	1.5	1.1	.1	- .45	- .4	5.0	13.45	8.15	14.3	8.05	4.0	2.9
8	1.5	1.1	.1	- .5	- .5	4.8	13.55	8.2	14.2	7.85	3.75	2.9
9	1.5	1.1	.1	- .45	- .6	4.5	13.75	8.55	14.15	7.75	3.55	2.8
10	1.5	1.1	.1	- .2	- .7	4.25	13.8	8.45	14.1	7.65	3.5	2.75
11	1.5	1.1	.1	.0	- .7	4.0	13.8	8.4	13.8	7.45	4.0	2.7
12	1.5	1.1	.1	1.9	- .7	3.7	13.8	10.15	13.1	7.25	4.15	2.65
13	1.5	1.0	.05	2.2	- .7	3.2	12.95	13.15	12.2	7.1	4.15	2.5
14	1.4	.95	.0	2.0	- .6	3.0	11.2	13.5	11.45	6.95	4.1	2.5
15	1.4	.9	.0	1.7	- .55	3.0	11.6	13.75	11.05	6.75	3.95	2.5
16	1.4	.8	.05	1.2	- .35	2.95	11.9	13.9	10.6	6.55	3.8	2.5
17	1.4	.6	.25	.95	.2	2.9	11.8	13.6	11.5	6.35	3.55	2.5
18	1.4	.6	.65	.75	.2	2.8	11.45	11.45	12.3	6.15	3.4	2.5
19	1.4	.5	1.2	.55	.2	2.75	11.2	9.7	13.9	6.5	3.3	2.5
20	1.4	.5	1.45	.15	.2	2.65	10.2	9.1	13.35	5.85	3.25	2.5
21	1.3	.5	1.2	- .2	.25	2.6	9.65	8.9	13.05	5.75	3.2	2.5
22	1.3	.4	.55	- .45	.3	2.45	11.05	8.8	12.9	6.05	3.15	2.55
23	1.3	.4	.4	- .6	.4	2.2	10.65	8.8	12.75	6.45	3.1	2.45
24	1.3	.4	.4	- .7	.6	2.2	8.75	9.75	12.65	6.25	3.0	2.55
25	1.3	.3	.35	- .7	1.2	2.35	7.95	10.05	12.9	5.85	3.0	2.75
26	1.3	.3	.3	- .8	2.3	2.6	8.35	10.45	13.55	5.45	3.0	2.8
27	1.3	.3	.2	- .8	2.95	3.2	12.1	11.85	12.4	5.25	3.0	2.9
28	1.2	.3	.1	- .8	3.35	3.6	11.05	12.35	11.1	5.05	2.9	2.9
29	1.2	....	.0	- .8	7.3	3.95	8.3	13.15	10.55	4.85	2.9	2.9
30	1.2	....	- .05	- .8	9.3	4.3	7.45	13.65	10.3	4.65	2.9	2.9
31	1.2	....	- .1	....	7.25	....	6.65	13.9	....	4.5	....	2.9

CONEJOS RIVER BASIN.

CONEJOS RIVER NEAR MOGOTE, COLO.

Conejos River, the most important tributary of the Rio Grande in Colorado, rises on the eastern slope of the San Juan Range, which forms the western boundary of Conejos County. It first flows southeastward, but at the town of Conejos bends northeastward and enters the Rio Grande below the mouth of Trinchera Creek.

The gaging station, which was established March 21, 1907, replacing the station formerly maintained about 4 miles below, is located at a private highway bridge on Jacob's ranch, about 16 miles above Antonito, Colo., in T. 33 N., R. 6 E., New Mexico principal meridian. It is above every important diversion for irrigation and below all the principal tributaries except the San Antonio.

The datum of the chain gage, which is on the bridge, has not been changed since the station was established. This gage is at the same datum as the rod gage used by Antoine Jacob during 1905 and 1906. The gage heights for these years have been furnished to the United States Geological Survey by him from his private records. Discharge measurements are also made from the highway bridge.

The data obtained at this station show the amount of water available for irrigation.

Water taken from the Conejos by numerous ditches below the station is used to irrigate 70,000 to 80,000 acres of land. The basin above the station affords excellent opportunities for storage, none of which are utilized at the present time. It will be difficult to secure additional water rights for irrigation along this stream.

The river is covered with ice for three or four months during the winter season. The stream bed is strewn with cobblestones and bowlders, and the water has a comparatively high velocity at all stages, making conditions unfavorable for accurate measurement. Eddies around the crib piers of the bridge also introduce uncertainty in the results.

A view of the river at this station is shown in Plate V, *B*.

Discharge measurements of Conejos River near Mogote, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 15	W. B. Freeman	121	314	2.35	1.070
June 23	....do	126	369	2.80	1,710
Aug. 3	G. H. Russell	90.5	153	1.00	272
Sept. 30	....do	62	92.5	.65	124
Nov. 13 [a]	J. B. Stewart	59	76	.35	57
Dec. 20 [b]	G. H. Russell	46	33	....	74

[a] Ice along edge of stream. [b] Made about 8 miles below station.

Daily gage height, in feet, of Conejos River near Mogote, Colo., for 1909.

[Francisque Jacob, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	1.4	2.5	2.2	0.95	1.35	0.60	0.5	0.45
2	....	1.45	2.65	2.3	1.05	1.4	.6	.45	.45
3	....	1.85	2.95	2.25	1.05	1.4	.6	.4	.5
4	....	2.2	3.25	2.15	1.05	1.45	.7	.4	.5
5	....	2.7	3.55	2.1	1.1	2.1	.85	.4	.4
6	....	2.7	3.65	2.1	1.2	2.5	1.0	.4	.4
7	....	2.8	3.55	2.05	1.25	2.45	1.0	.4	.4
8	....	2.8	3.45	2.05	1.15	2.2	1.05	.4	.5
9	....	2.4	3.4	1.95	1.1	1.9	.85	.4	.5
10	....	2.45	3.35	1.85	1.15	1.8	.8	.4	.5
11	....	2.4	3.25	1.8	1.0	1.7	.8	.4	.5
12	....	2.45	3.3	1.7	1.0	1.55	.8	.5	.4
13	....	2.4	3.2	1.55	1.2	1.6	.8	.4	.4
14	....	2.5	3.05	1.4	1.05	1.5	.8	.4	.5
15	....	2.45	2.95	1.35	1.0	1.5	.8	.5	.5
16	....	2.6	2.95	1.3	1.1	1.4	.7	.5	.4
17	....	2.7	2.95	1.25	1.0	1.3	.7	.5	.4
18	....	2.8	3.1	1.25	1.05	1.25	.7	.5	.4
19	....	2.9	3.0	1.25	1.0	1.2	.7	.5	.4
20	....	2.7	3.05	1.25	1.0	1.1	.7	.5	.4
21	....	2.7	3.05	1.2	1.0	1.1	.6	.5	.4
22	....	2.7	2.95	1.25	.95	1.1	.6	.6	.4
23	....	2.45	2.8	1.25	1.15	1.1	.6	.5	.4
24	....	2.3	2.8	1.4	1.25	.95	.6	.4	.4
25	1.35	2.2	2.75	1.35	1.4	.95	.6	.4	.4
26	1.35	2.35	2.6	1.25	1.25	.85	.6	.4	.3
27	1.55	2.5	2.55	1.2	1.4	.85	.6	.4	.3
28	1.65	2.75	2.4	1.1	1.35	.7	.55	.4	.4
29	1.65	2.6	2.4	1.1	1.9	.7	.55	.45	.4
30	1.3	2.4	2.35	1.1	1.6	.65	.55	.5	.4
31	....	2.4	....	.95	1.45	....	.55	....	.4

NOTE.—Probable ice conditions December 1-31, but it is believed that the gage heights were affected but little.

Daily discharge, in second-feet, of Conejos River near Mogote, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		353	1,230	1,010	222	388	120	95	85
2		378	1,430	1,120	259	413	120	85	85
3		618	1,900	1,060	259	413	120	75	95
4		900	2,420	960	259	440	147	75	95
5		1,500	2,940	910	278	910	190	75	75
6		1,500	3,120	910	319	1,360	240	75	75
7		1,650	2,940	865	341	1,300	240	75	75
8		1,650	2,770	865	298	1,010	259	75	95
9		1,110	2,680	780	278	740	190	75	95
10		1,170	2,590	701	298	662	175	75	95
11		1,110	2,420	662	240	592	175	75	95
12		1,170	2,500	592	240	498	175	95	75
13		1,110	2,330	498	319	528	175	75	75
14		1,230	2,070	413	259	468	175	75	95
15		1,170	1,900	388	240	468	175	95	95
16		1,360	1,900	363	278	413	147	95	75
17		1,500	1,900	341	240	363	147	95	75
18		1,650	2,160	341	259	341	147	95	75
19		1,810	1,980	341	240	319	147	95	75
20		1,500	2,070	341	240	278	147	95	75
21		1,500	2,070	319	240	278	120	95	75
22		1,500	1,900	341	222	278	120	120	75
23		1,170	1,650	341	298	278	120	95	75
24		1,000	1,650	413	341	222	120	75	75
25	330	900	1,580	388	413	222	120	75	75
26	330	1,060	1,360	341	341	190	120	75	60
27	430	1,230	1,300	319	413	190	120	75	60
28	488	1,580	1,110	278	388	147	108	75	75
29	488	1,360	1,110	278	740	147	108	85	75
30	308	1,110	1,060	278	528	134	108	95	75
31		1,110		222	440		108		75

NOTE.—The above discharges are based on a rating curve that is fairly well defined below 400 second-feet. Discharges December 1–31 may be slightly affected by ice.

Monthly discharge of Conejos River near Mogote, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April 25–30	488	308	396	4,710	B.
May	1,810	353	1,220	75,000	B.
June	3,120	1,060	2,000	119,000	B.
July	1,120	222	548	33,700	B.
August	740	222	314	19,300	B.
September	1,360	134	466	27,700	B.
October	259	108	151	9,280	C.
November	120	75	84.5	5,030	C.
December	95	60	79.8	4,910	D.
The period				299,000	

SANTA FE CREEK BASIN.

SANTA FE CREEK AT SANTA FE, N. MEX.

Santa Fe Creek rises on the range east of Santa Fe and flows westward over high plains to join the Rio Grande south of the Espanola Valley.

The gaging station, which was established May 31, 1907, to determine the amount of water available for irrigation and storage, is located at the Don Gaspar Avenue Bridge in the city of Santa Fe.

The gage datum was changed on August 13, 1908, and again on August 22, 1908. Results obtained at this station have been very unsatisfactory owing to the torrential character of the stream, the shifting nature of the bed, and the inadequate number of discharge measurements.

Discharge measurements are made from the downstream side of the bridge.

No important tributaries except intermittent streams enter below the station. The drainage area at the station is about 40 square miles, and at the mouth of the river it is about 300 square miles.

The reservoir for the Santa Fe municipal supply is situated in the canyon above the station and a water-power plant of 100-horsepower capacity is used to develop power for lighting. Very little water is diverted for irrigation above the station. One small ditch takes water out just above. In the canyon 8 miles above Santa Fe is a reservoir site where 10,000 acre-feet can be stored.

Ice is usually to be found in the stream during the winter months, though the flow is very small during that period. The low-water flow is regulated to some extent by the waterworks reservoir above.

Discharge measurements of Santa Fe Creek at Santa Fe, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 8	J. B. Stewart	9	3	0.05	5.2
Aug. 25	Sullivan and Stewart	30	27	.55	169
Do	J. B. Stewart	27.5	18	.30	69
Oct. 5	W. B. Freeman			− .10	*a* .2

a Estimated.

NOTE.—Measurements made at various sections.

Daily gage height, in feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	−0.3	−0.25	−0.4	−0.3	−0.1	−0.4	−0.5	−0.6	−0.4	−0.1	−0.15	−0.1
2	− .3	− .2	− .3	− .3	− .3	− .4	− .5	− .6	− .45	− .1	− .15	− .1
3	− .5	− .2	− .3	− .3	− .3	− .3	− .5	− .5	− .3	− .1	− .15	− .1
4	− .3	− .35	− .4	− .4	− .3	− .3	− .5	− .35	− .45	− .1	− .15	− .1
5	− .4	− .25	− .4	− .4	− .2	− .2	− .4	− .4	+ .25	− .1	− .15	− .1
6	− .3	− .2	− .4	− .4	− .2	.0	− .5	− .4	+ .1	.0	− .15	− .1
7	− .3	− .3	− .3	− .4	− .1	.0	− .5	− .6	.4	+ .05	− .15	− .1
8	− .3	− .4	− .3	− .4	− .1	− .2	− .5	− .6	.4	.0	− .15	− .1
9	− .3	− .4	− .3	− .4	− .05	− .2	− .5	− .5	.3	.0	− .15	− .1
10	− .3	− .3	− .4	− .4	− .05	− .25	− .5	− .4	.35	.0	− .15	− .1
11	− .25	− .3	− .35	− .4	− .05	− .1	− .5	− .5	.3	+ .1	− .1	− .1
12	− .3	− .4	− .3	− .4	− .05	− .2	− .5	− .6	.3	.1	− .1	− .1
13	− .25	− .4	− .3	− .4	− .05	− .2	− .2	− .4	.4	.1	− .1	− .1
14	− .25	− .4	− .2	− .4	− .05	− .25	− .5	− .4	.0	+ .1	− .1	− .1
15	− .3	− .45	− .2	− .4	− .05	− .3	− .5	− .15	.15	− .1	− .1	− .1
16	− .2	− .45	− .2	− .45	− .1	− .3	− .5	− .4	.2	− .1	− .1	− .1
17	− .2	− .45	− .3	− .45	− .1	− .4	− .5	....	.1	− .1	− .1	− .1
18	− .3	− .45	− .35	− .45	− .1	− .4	− .5	....	.15	− .1	− .1	− .1
19	− .3	− .45	− .35	− .4	− .25	− .15	− .5	....	.15	− .1	− .1	− .1
20	− .25	− .4	− .4	− .5	+ .1	− .15	− .5	....	.1	− .1	− .1	− .1

Daily gage height, in feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	−0.2	−0.4	−0.45	−0.5	+0.2	−0.25	−0.5	....	+0.05	−0.1	−0.1	−0.1
22	− .2	− .3	− .45	− .4	− .1	− .4	− .5	....	.0	− .1	− .1	− .1
23	− .15	− .3	− .45	− .3	− .1	− .35	− .5	....	.0	− .1	− .1	− .1
24	− .3	− .2	− .45	− .2	− .05	− .5	− .5	−0.1	.0	− .1	− .1	− .1
25	− .2	− .3	− .3	− .45	− .05	− .5	+ .1	− .1	.0	− .1	− .1	− .1
26	− .15	− .45	− .3	− .45	− .1	− .5	.0	.0	− .1	− .1	− .1	− .1
27	− .2	− .5	− .35	− .4	− .3	− .4	− .3	....	− .1	− .1	+ .2	.0
28	− .2	− .5	− .3	− .3	− .4	− .5	− .4	....	− .1	− .1	+ .2	.0
29	− .25	....	− .3	− .15	− .4	− .3	− .4	....	− .1	− .1	.0	.0
30	− .3	....	− .3	− .4	− .4	− .5	− .4	....	− .1	− .1	.0	.0
31	− .2	....	− .3	....	− .4	....	− .4	− .4	....	− .1	....	.0

NOTE.—Ice conditions during January and February.

Daily discharge, in second-feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1907–1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	....	....	....	....	....	19	0.5	0.5	34	0.5	1.0	3.5
2	....	....	....	....	....	20	.5	.5	20	.5	1.0	6.3
3	....	....	....	....	....	20	.5	3.5	27	.5	1.0	1.5
4	....	....	....	....	....	20	.5	1.5	20	.5	1.0	1.3
5	....	....	....	....	....	20	.5	2.5	11	.5	1.0	1.5
6	....	....	....	....	....	20	.5	.5	20	.5	1.3	2.5
7	....	....	....	....	....	22	.5	.5	11	.5	1.3	3.5
8	....	....	....	....	....	22	.5	.5	15	.5	1.3	3.5
9	....	....	....	....	....	20	1.0	.5	13	.5	1.3	3.5
10	....	....	....	....	....	20	.5	.5	11	.5	1.1	4.9
11	....	....	....	....	....	18	1.0	.5	6.3	.5	1.1	3.5
12	....	....	....	....	....	18	.5	.5	1.5	.5	1.0	3.5
13	....	....	....	....	....	15	.5	.5	.5	.5	1.0	6.3
14	....	....	....	....	....	15	.5	.5	.5	.5	1.0	6.3
15	....	....	....	....	....	11	.5	.5	.5	.5	1.3	8.6
16	....	....	....	....	....	14	.5	.5	1.5	.5	1.0	6.3
17	....	....	....	....	....	14	.5	.5	.5	.5	1.0	6.3
18	....	....	....	....	....	11	.5	.5	1.0	.5	1.0	6.3
19	....	....	....	....	....	15	.5	1.0	.5	.5	1.1	8.6
20	....	....	....	....	....	20	.5	1.0	1.0	.5	1.1	8.6
21	....	....	....	....	....	11	.5	.5	.7	1.0	1.0	6.3
22	....	....	....	....	....	11	.5	.5	.7	.5	1.0	4.9
23	....	....	....	....	....	8.6	.5	.5	.5	.5	1.5	6.3
24	....	....	....	....	....	8.6	.5	.5	.5	.5	2.5	4.9
25	....	....	....	....	....	5.7	.5	.5	.5	.5	2.5	4.9
26	....	....	....	....	....	3.5	.5	.5	.5	.5	2.5	4.9
27	....	....	....	....	....	2.5	.5	.5	.5	.5	3.1	3.5
28	....	....	....	....	....	2.5	1.0	.5	.5	.5	3.1	3.5
29	....	....	....	....	....	1.5	1.0	.5	.5	.7	3.5	4.9
30	....	....	....	....	....	1.0	.5	85	.5	.7	3.5	3.5
31	....	....	....	....	....	....	.5	34	....	.7	....	4.9
1908.												
1	6.2	1.0	0.9	0.0	0.5	8.5	.0	14	2.0	.4	.4	2.0
2	8.2	1.0	2.4	.0	.0	26	.0	90	1.1	.4	.4	2.0
3	6.2	1.8	1.6	.0	.8	5.2	.0	111	.4	.4	.4	2.0
4	4.5	1.0	1.6	.0	3.2	2.8	.0	111	.4	.4	.4	.4
5	6.2	1.0	2.4	.0	.0	3.8	.0	111	.4	.4	.4	.4
6	6.0	5.2	4.7	.0	.0	2.8	.0	111	.4	.4	.4	.4
7	6.0	5.2	2.4	.0	2.3	1.9	.0	111	.4	.4	.4	.1
8	6.0	3.8	.6	.0	.0	2.0	.0	111	.1	.4	.1	.1
9	6.0	2.6	3.4	.0	.0	2.0	.0	111	.1	.4	.4	.1
10	4.4	2.6	.6	.0	.0	.5	.0	111	.1	.4	.4	.1
11	4.4	2.6	3.4	.0	.0	9.8	.0	111	.1	.4	.4	.1
12	4.4	2.6	.8	.0	.8	5.8	.0	111	.1	.4	.4	.1
13	3.2	2.6	2.3	.0	2.1	4.4	.0	....	.1	.4	.4	.1
14	4.2	2.6	1.6	.0	1.3	.5	.0	....	.1	.4	.4	.1
15	4.2	3.7	.3	.0	.0	.5	....	....	.1	.4	.4	.1

Daily discharge, in second-feet, of Santa Fe Creek at Santa Fe, N. Mex., for 1907–1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
16	3.2	3.7	0.5	0.0	0.0	6.0	8.0	......	0.1	0.4	0.4	0.1
17	3.2	.9	.8	.0	1.3	4.6	8.0	186	.1	.4	.4	.1
18	4.0	2.5	.4	.0	1.3	.5	......	95	.1	.4	.4	.1
19	4.0	2.5	.2	.0	.7	.5	8.0	34	.1	.4	.4	.4
20	3.0	1.6	.2	.0	.0	.5	8.0	50	.1	.4	.4	1.1
21	3.0	2.5	.2	.0	.0	.4	14	22	.1	1.1	.4	1.1
22	2.9	3.5	.2	.5	6.0	.4	4.5	22	.1	5.5	.4	1.1
23	3.9	2.5	.2	.5	18	.4	8.0	32	.1	3.3	.4	1.1
24	2.8	2.5	.2	.5	8.0	.4	6.0	32	.1	1.1	1.1	.4
25	2.7	3.5	.2	.5	4.5	.4	8.0	22	.1	1.1	1.1	.4
26	1.0	2.5	.1	.8	1.3	.4	4.5	9.0	.1	2.0	1.1	.4
27	1.0	4.8	.1	1.5	.8	1.5	4.5	5.5	.1	2.0	1.1	.4
28	2.6	2.5	.1	2.2	1.5	.3	4.5	5.5	.1	1.1	2.0	.0
29	2.6	3.5	.1	.0	1.5	.3	2.0	2.0	.1	2.0	2.0	.1
30	2.6	......	.1	.0	.4	.0	4.5	3.3	.1	1.1	2.0	.1
31	2.6	......	.1	......	.4	......	10	3.3	......	.8	......	1.1
1909.												
1	1.1	1.6	.4	1.1	3.3	.4	.0	.0	.0	.2	.2	.2
2	1.1	2.0	1.1	1.1	1.1	.4	.0	.0	.0	.2	.2	.2
3	.1	2.0	1.1	1.1	1.1	1.1	.0	.0	.0	.2	.2	.2
4	1.1	.8	.4	.4	1.1	1.1	.0	.2	.0	.2	.2	.2
5	.4	1.6	.4	.4	2.0	2.0	.2	.2	47	.2	.2	.2
6	1.1	2.0	.4	.4	2.0	5.5	.0	.2	31	2.0	.2	.2
7	1.1	1.1	1.1	.4	3.3	5.5	.0	.0	72	2.0	.2	.2
8	1.1	.4	1.1	.4	3.3	2.0	.0	.0	72	2.0	.2	.2
9	1.1	.4	1.1	.4	4.4	2.0	.0	.0	53	2.0	.2	.2
10	1.1	1.1	.4	.4	4.4	1.6	.0	.2	62	2.0	.2	.2
11	1.6	1.1	.8	.4	4.4	3.3	.0	.0	53	2.0	.2	.2
12	1.1	.4	1.1	.4	4.4	2.0	.0	.0	53	2.0	.2	.2
13	1.6	.4	1.1	.4	4.4	2.0	6.0	.2	72	2.0	.2	.2
14	1.6	.4	2.0	.4	4.4	1.6	.0	.2	3.0	2.0	.2	.2
15	1.1	.2	2.0	.4	4.4	1.1	.0	2.0	14	.2	.2	.2
16	2.0	.2	2.0	.2	3.3	1.1	.0	.2	20	.2	.2	.2
17	2.0	.2	1.1	.2	3.3	.4	.0	2.0	9.0	.2	.2	.2
18	1.1	.2	.8	.2	3.3	.4	.0	5.0	14	.2	.2	.2
19	1.1	.2	.8	.4	1.6	2.6	.0	10	14	.2	.2	.2
20	1.6	.4	.4	.1	9.0	2.6	.0	3.0	9.0	.2	.2	.2
21	2.0	.4	.2	.1	14	1.6	.0	5.0	5.0	.2	.2	.2
22	2.0	1.1	.2	.4	3.3	.4	.0	5.0	3.0	.2	.2	.2
23	2.6	1.1	.2	1.1	3.3	.8	.0	2.0	3.0	.2	.2	.2
24	1.1	2.0	.2	2.0	4.4	.1	.0	4.0	3.0	.2	.2	.2
25	2.0	1.1	1.1	.2	4.4	.1	2.0	4.0	3.0	.2	.2	.2
26	2.6	.2	1.1	.2	3.3	.1	1.0	15	.2	.2	.2	.2
27	2.0	.1	.8	.4	1.1	.4	.4	12	.2	.2	4.0	.2
28	2.0	.1	1.1	1.1	.4	.1	.2	10	.2	.2	4.0	.2
29	1.6	......	1.1	2.6	.4	1.1	.2	10	.2	.2	2.0	.2
30	1.1	......	1.1	.4	.4	.1	.2	10	.2	.2	2.0	.2
31	2.0	......	1.1	......	.4	......	.2	.0	......	.2	......	.2

NOTE.—Discharges June 1 to December 31, 1907, were obtained from a rating curve that is not well defined; January 1 to August 1, 1908, by the indirect method for shifting channels; August 2–12, 1908, estimated; August 17, 1908, to June 30, 1909, from a rating curve that is fairly well defined; July 1 to December 31, 1909, estimated by the hydrographer.

Monthly discharge of Santa Fe Creek at Santa Fe, N. Mex., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
June	22.0	1.0	13.7	815	D.
July	1.0	.5	.56	34	D.
August	85.0	.5	4.53	279	D.
September	34.0	.5	6.71	399	D.
October	1.0	.5	.54	33	D.
November	3.5	1.0	1.54	92	D.
December	8.6	1.3	4.80	295	D.
The period				1,950	
1908.					
January	8.2	1.0	4.04	248	D.
February	5.2	.9	2.70	155	D.
March	4.7	.1	1.06	65	D.
April	2.2	.0	.22	13	D.
May	18	.0	1.65	101	D.
June	26	.0	3.10	184	D.
July (29 days)	14	.0	3.53	203	D.
August (27 days)	186	2.0	64.4	3,450	D.
September	2.0	.1	.25	15	D.
October	5.5	.4	.94	58	D.
November	2.0	.1	.64	38	D.
December	2.0	.0	.52	32	D.
The period				4,560	
1909.					
January	2.6	0.1	1.45	89	D.
February	2.0	.1	.81	45	D.
March	2.0	.2	.90	55	D.
April	2.6	.1	.59	35	D.
May	14.0	.4	3.36	207	D.
June	5.5	.1	1.45	86	D.
July	6.0	.0	.34	21	D.
August	15.0	.0	3.24	199	D.
September	72.0	.0	20.5	1,220	D.
October	2.0	.2	.72	44	D.
November	4.0	.2	.57	34	D.
December	.2	.2	.20	12	D.
The year	72.0	.0	2.84	2,050	

FLOOD ON BLUEWATER CREEK, N. MEX., SEPTEMBER 6, 1909.

By W. B. Freeman, district engineer.

In the early part of September, 1909, there were very heavy rains in nearly every part of New Mexico, which caused great floods and did considerable damage. The storm from September 4 to 6 in the Zuni Mountains, following frequent and heavy rains in July and August, resulted in the failure of the Zuni dam at Blackrock and the Bluewater dam on Bluewater Creek, some distance above Bluewater station on the Santa Fe Railway, in Valencia County.

The flood on Zuni River and the failure of the Zuni dam are described in Water-Supply Paper 269, and also in the Engineering News of August 25, 1910.

The Bluewater dam, which had been completed about four years, was located in the canyon just below the junction of Azul Creek with Bluewater Creek, about 10 miles west of Bluewater. It might be termed an earth and rock fill dam, some 300 feet long on top and about 35 feet high. The slopes averaged probably 2½ to 1, or over, and the dam was riprapped on the inside slope. The central portion of the dam was made up of stratified limestone, which from the section exposed by the failure appears to have been laid by hand. The dam did not rest on or go down to bedrock, but the foundation was only about 10 feet above bedrock, which is of limestone and fairly uniform in elevation across the canyon. Both the inner and outer slopes of the dam were of earth.

The capacity of the reservoir is not known. The cost of the dam is believed to have been about $35,000.

The approximate drainage area above the dam is 240 square miles, much of which is fairly well forested. The elevations range from 7,000 feet to about 9,200 feet on the tops of the mountanis which form the Continental Divide.

The dam-site is a very good one. It was first surveyed by the United States Geological Survey, and is described as Reservoir No. 33, on page 195 of part 2 of the Twelfth Annual Report. According to that report the reservoir would have a capacity of 53,000 acre-feet and an area of 1,900 acres, with a dam 74.5 feet high.

Mr. R. M. Jones, an engineer of Denver, Colo., was at the dam a short time before its failure, making estimates for its enlargement, and was there also immediately after its failure. He had an opportunity to talk to the watchman at the dam, who was present when it failed. It appears that the particular storm which caused its destruction followed in a general way the crest of the Zuni Mountains and was what is commonly known as a cloudburst. Old residents in that vicinity stated that the rainfall was by far the heaviest that they had ever witnessed. The water in the reservoir did not rise gradually but rather by large increments, as the flood from each tributary arrived separately, the time depending largely on the distance the water had to travel—that is, the flood water from one stream would come down in a rush, causing a sudden rise in the reservoir, which would remain practically stationary for a few minutes, when the waters from another stream would come rushing down. The result was that the reservoir was soon filled and, the spillway being inadequate to take care of the excess waters, the dam was topped to a depth of about 1½ feet. It was then torn out by the flood waters, which cut a channel to bedrock and left only the ends of the dam standing. This violent storm was evidently only of short duration, but the run-off was tremendous. No estimate even can be made of its amount.

The dam failed on the afternoon of September 6, just a few minutes before the failure of the Zuni dam, which went out as a result of the same storm.

The Bluewater dam was owned by the Bluewater Development Company. A small dam at the same site was washed out several years ago.

A description of the flood and the failure of the dam, by C. E. Linney, section director, United States Weather Bureau, is to be found on page 639 of the Monthly Weather Review for September, 1909.

The accompanying tables show the rainfall at various points in that vicinity during August and the first part of September.

Daily precipitation in inches in the vicinity of Bluewater dam, New Mexico, from August 1 to September 6, 1909.

Day.	Blackrock.	Bluewater station.	Bluewater reservoir.	Fort Wingate.	San Rafael.	Manuelito.
AUG.						
1	......	0.30	0.71	0.10	0.51	0.15
2	0.35	......	......	Tr.	......	1.05
3	.29	.18	Tr.	......	.29	......
4	.35	......	......	.20	.82	.10
5	.28	.13	......	.20	.17	......
6	......	......	......	.50	......	Tr.
7	.09	......	.20	.20	......	.50
8	......	......	......	.10	......	.35
9	.13	.27	......	.20	......	.20
10	.10	.04	......	......	......	.70
11	.04	.05	Tr.	Tr.	1.52	......
12	......	.48	Tr.	Tr.	1.18	.20
13	Tr.	......	*	......	......	......
14	.08	......	.50	......	.50	......
15	Tr.	......	......	Tr.	......	......
16	Tr.	......	.32	.50	.74	......
17	.01	.28	......	.10	.19	......
18	.06	......	.18	.20	.60	......
19	.02	.38	.22	Tr.	.76	......
20	Tr.	......	......	.30	......	......
AUG.—con.						
21	......	0.28	0.62	0.20	0.90	......
22	Tr.	......	.29	......	......	0.50
23	.63	......	Tr.	.20	......	3.00
24	.07	......	......	......	......	......
25	Tr.	.37	Tr.	1.30	......	......
26	Tr.	.58	Tr.	.50	.44	......
27	Tr.	......	.03	.20	......	......
28	Tr.	......	Tr.	Tr.	.45	......
29	.13	.12	......	.20	.96	.50
30	.20	.63	*	.20	......	.30
31	......	......	.66	......	......	......
Total for month..	2.83	4.09	3.73	5.40	10.03	7.55
SEPT.						
1	0.03	......	Tr.	0.40	0.18	0.50
2	......	......	......	......	......	......
3	.04	......	.63	.32	.38	......
4	.20	......	.91	1.20	......	.50
5	.60	......	.42	.59	.88	.20
6	.46	......	Tr.	1.20	.70	.01

MIMBRES RIVER BASIN.

MIMBRES RIVER NEAR FAYWOOD, N. MEX.

The station, which is located about 6 miles southeast of Faywood Hot Springs and 10 miles from Faywood station, on the Silver City branch of the Santa Fe Railway, was established April 23, 1908, to determine the amount of water available for storage.

No important tributaries enter in the vicinity of the station, though many intermittent tributaries come in both above and below. The drainage area is about 450 square miles.

Some water is used for irrigation in the Mimbres Valley below the station, but as this is primarily a flood stream and as storage has not been provided, such irrigation is uncertain. By storing the flood water and cutting off the underflow at the Rio Mimbres dam site, it will be possible to reclaim several thousand acres of land along this stream.

The gage is located about 400 feet below the proposed Rio Mimbres reservoir dam site. The gage datum was lowered 4 feet on July 8, 1909, and was afterwards raised 3 feet on August 13, 1909, when a Friez automatic gage was installed 200 feet above the chain gage on the right bank. (See Pl. VI, *A*.)

The flow of the stream at the gaging station is not usually affected by ice during the winter months. As the channel is very shifting in character, frequent measurements are necessary at high and medium stages to obtain the best results. Measurements during high stages are made from a cable 1,000 feet below the automatic gage.

Discharge measurements of Mimbres River near Faywood, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 6	J. B. Stewart	21.5	5.4	3.90	8.8
Feb. 3	do	8.8	3.8	3.60	5.2
Apr. 27	do	7.0	1.6	3.65	2.0
June 10	do	8.0	1.8	3.70	1.1
July 8	do	8.3	1.6	3.90	1.4
Aug. 13	do	79.5	44.3	4.70	164
Aug. 20	do	11.5	2.1	[a] 1.16	1.5
Sept. 1	do	17	3.2	[b] 1.30	3.5
Oct. 12	W. B. Freeman	11.6	2.8	[c] 1.18	3.8

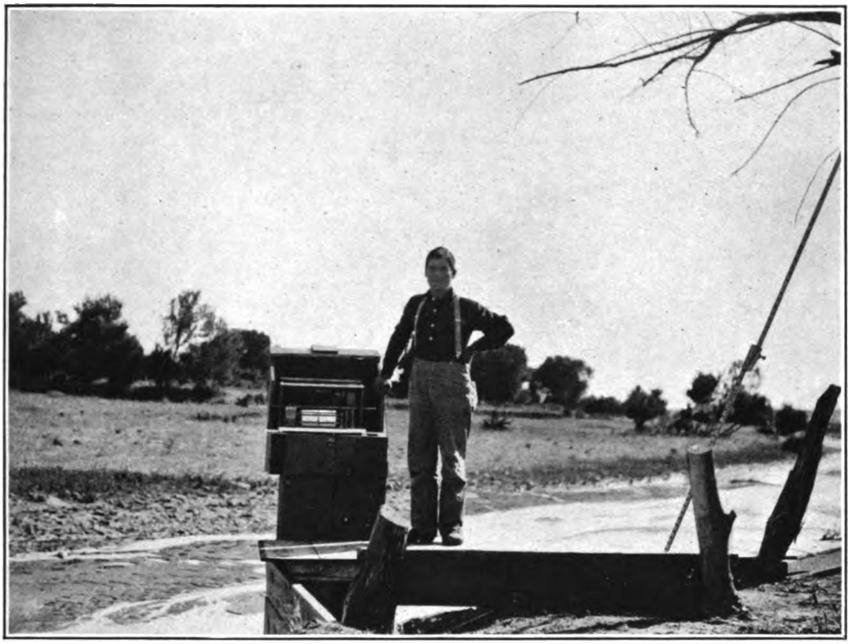
[a] Chain gage read 4.15 feet. [b] Chain gage read 4.30 feet. [c] Chain gage read 4.20 feet.

Daily gage height, in feet, of Mimbres River near Faywood, N. Mex., for 1909.

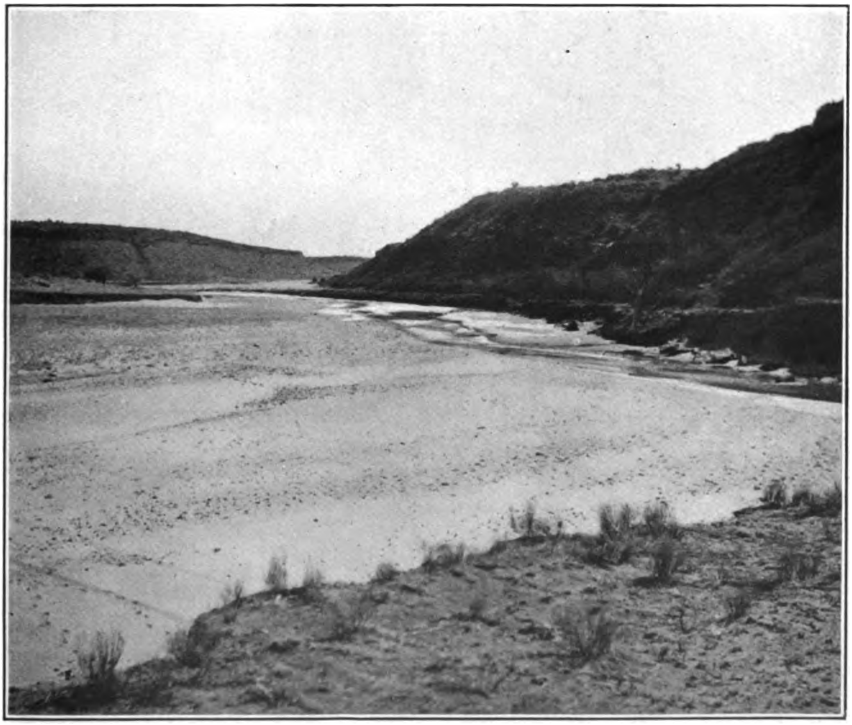
[Ralph C. Trujillo, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.2	3.8	3.7	3.7	3.7	3.7	3.75	3.85	1.3	1.15	1.2	1.05
2	4.2	3.8	3.7	3.7	3.65	3.7	3.85	3.85	1.25	1.15	1.2	1.05
3	4.1	3.6	3.7	3.7	3.65	3.7	4.05	3.85	1.3	1.15	1.2	1.05
4	4.0	3.6	3.7	3.6	3.65	3.7	3.8	3.9	1.3	1.15	1.2	1.05
5	4.0	3.7	3.7	3.6	3.7	3.7	3.75	3.9	1.5	1.15	1.2	1.0
6	3.9	3.8	3.7	3.6	3.7	3.7	3.9	3.95	1.2	1.15	1.2	1.0
7	3.9	3.7	3.7	3.6	3.65	3.7	4.1	3.95	1.1	1.15	1.2	1.0
8	3.9	3.7	3.7	3.6	3.7	3.7	3.9	3.95	1.05	1.15	1.2	1.0
9	3.8	3.7	3.7	3.7	3.7	3.7	3.9	3.9	1.05	1.15	1.2	1.0
10	3.8	3.7	3.7	3.7	3.7	3.7	3.9	3.95	1.15	1.2	1.2	.95
11	3.8	3.6	3.7	3.7	3.65	3.7	3.9	4.0	1.45	1.2	1.2	.95
12	3.8	3.6	3.7	3.7	3.65	3.7	3.9	4.1	1.35	1.2	1.2	.95
13	3.9	3.6	3.8	3.7	3.7	3.75	4.6	4.0	1.35	1.2	1.2	.95
14	3.9	3.6	3.9	3.7	3.7	3.75	3.95	4.55	1.3	1.2	1.2	.95
15	3.9	3.6	3.8	3.7	3.75	3.75	3.95	4.55	1.25	1.2	1.2	.9
16	3.9	3.6	3.7	3.7	3.75	3.75	3.9	1.3	1.25	1.2	1.2	.9
17	3.9	3.6	3.7	3.7	3.75	3.75	3.9	1.2	1.25	1.2	1.15	.9
18	3.9	3.6	3.7	3.7	3.75	3.7	3.9	1.1	1.25	1.2	1.2	.9
19	3.9	3.7	3.7	3.6	3.75	3.75	3.9	1.1	1.2	1.2	1.2	.9
20	3.9	3.7	3.7	3.6	3.75	3.75	4.0	1.15	1.2	1.2	1.2	.9
21	3.8	3.8	3.7	3.6	3.75	3.8	4.0	1.15	1.15	1.2	1.2	.9
22	3.8	3.8	3.7	3.6	3.75	3.8	3.95	1.2	1.15	1.2	1.15	.9
23	3.8	3.8	3.7	3.6	3.7	3.8	3.9	1.45	1.15	1.2	1.1	.9
24	3.8	3.7	3.7	3.6	3.7	3.8	3.95	1.35	1.15	1.2	1.1	.9
25	3.8	3.7	3.8	3.6	3.7	3.8	4.0	1.3	1.15	1.2	1.1	.9
26	3.8	3.7	3.9	3.65	3.65	3.75	4.0	1.2	1.15	1.2	1.1	.95
27	4.0	3.7	3.9	3.65	3.65	3.75	3.9	1.2	1.15	1.2	1.1	.95
28	3.9	3.7	3.8	3.7	3.65	3.75	3.9	1.2	1.15	1.2	1.1	.95
29	3.8	....	3.8	3.7	3.7	3.85	3.9	1.2	1.15	1.2	1.1	1.0
30	3.8	....	3.7	3.7	3.7	3.95	3.95	1.2	1.15	1.2	1.1	1.0
31	3.8	....	3.7	....	....	....	4.0	1.4	....	1.2	....	1.0

NOTE.—July 8 gage datum lowered 4.0 feet. All gage heights from January 1 to July 7 have been reduced to new datum. On August 16 a Friez automatic gage was installed about 200 feet above chain gage. The Freiz gage reads about 3 feet lower than the chain gage, but its zero is about 0.4 foot above that of the chain gage.



A. AUTOMATIC GAGE ON MIMBRES RIVER NEAR FAYWOOD, N. MEX.



B. PECOS RIVER VALLEY BETWEEN RIBERA AND FORT SUMNER, N MEX.

Daily discharge, in second-feet, of Mimbres River near Faywood, N. Mex., for 1908–9.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	......	......	......	......	13.4	15.5	10.1	39	41	42	28	28
2	......	......	......	......	13.4	15.6	10.2	143	41	42	16	28
3	......	......	......	......	25	15.7	10.3	108	520	61	16	28
4	......	......	......	......	25	15.8	10.3	56	112	61	16	17
5	......	......	......	......	13.4	7.8	10.3	39	41	42	16	17
6	......	......	......	......	13.4	7.8	10.4	24	41	61	16	17
7	......	......	......	......	13.4	7.9	10.4	39	41	61	16	17
8	......	......	......	......	13.4	7.9	10.5	39	41	61	16	17
9	......	......	......	......	13.4	8.0	21	39	41	42	28	17
10	......	......	......	......	13.4	8.0	35	39	41	61	28	17
11	......	......	......	......	13.4	8.1	35	39	41	61	28	17
12	......	......	......	......	6.3	8.2	21	24	41	61	28	17
13	......	......	......	......	6.3	8.3	10.8	24	41	61	44	30
14	......	......	......	......	6.4	8.4	345	24	41	61	44	46
15	......	......	......	......	6.5	8.5	34	220	41	61	28	46
16	......	......	......	......	6.6	8.6	72	108	41	42	16	65
17	......	......	......	......	6.8	8.7	435	57	59	42	16	46
18	......	......	......	......	6.9	8.8	53	39	59	42	28	46
19	......	......	......	......	7.0	8.9	53	39	41	42	28	16
20	......	......	......	......	14.6	9.0	53	345	59	42	16	30
21	......	......	......	......	14.7	9.1	36	79	41	42	16	30
22	......	......	......	......	14.8	9.2	22	39	59	42	16	30
23	......	......	......	......	14.9	9.3	10.6	39	41	42	16	30
24	......	......	......	......	15.0	9.4	10.6	39	41	42	28	30
25	......	......	......	......	15.1	9.5	515	39	41	61	28	46
26	......	......	......	......	7.4	9.6	345	57	59	61	28	46
27	......	......	......	......	7.5	9.7	630	910	59	61	28	46
28	......	......	......	......	7.6	9.8	515	56	41	44	28	30
29	......	......	......	......	7.7	9.9	435	39	42	44	28	30
30	......	......	......	......	7.8	10.0	106	1,000	42	44	28	30
31	......	......	......	......	7.8	......	38	59	......	28	......	30
1909.												
1	46	21	7.8	5.0	3.0	1.6	0.1	1.7	3.5	2.0	7.0	3.5
2	46	21	7.8	5.0	1.8	1.5	1.1	1.7	2.0	2.0	7.0	3.5
3	30	5.2	7.8	5.0	1.8	1.5	7.8	1.7	4.0	2.0	7.0	3.5
4	17	4.6	7.8	2.0	1.8	1.4	.4	2.7	4.0	2.0	7.0	3.5
5	17	10	7.8	2.0	3.0	1.4	.1	3.5	18	2.0	7.0	2.0
6	8.8	20	7.8	2.0	3.0	1.3	1.7	5.4	2.5	2.0	7.5	2.0
7	8.5	10	6.7	1.6	1.5	1.2	9.1	5.4	1.0	2.0	7.5	2.0
8	8.5	10	6.7	1.6	2.4	1.1	1.4	5.4	.5	2.0	7.5	2.0
9	4.4	10	6.7	4.0	2.4	1.1	1.6	3.5	.5	2.0	7.5	2.0
10	5.0	10	6.7	4.0	2.4	1.1	1.6	5.4	1.0	4.0	7.5	2.0
11	6.0	4.6	6.7	4.0	1.5	.8	1.6	9.0	15	4.0	8.0	2.0
12	6.0	4.6	6.7	4.0	1.5	.8	1.6	18	8.0	4.0	8.0	2.0
13	13	4.6	14	4.0	2.4	1.6	93	9.0	8.0	4.5	8.0	2.0
14	13	4.6	25	4.0	2.4	1.6	2.7	108	5.5	4.5	8.0	2.0
15	15	4.0	14	4.0	3.2	1.3	2.7	108	4.0	5.0	8.0	1.5
16	15	4.0	6.7	4.0	3.2	1.3	1.6	7.0	4.0	5.0	8.0	1.5
17	15	4.0	6.7	3.5	3.2	1.3	1.6	3.0	4.0	5.0	6.0	1.5
18	15	4.0	4.8	3.5	3.2	.5	2.2	1.0	4.0	5.0	8.5	1.5
19	20	8.8	4.8	2.6	3.2	.7	2.2	1.0	2.0	5.0	8.5	1.5
20	20	8.8	4.8	2.6	3.2	.7	5.3	1.5	2.0	5.5	8.5	1.5
21	10.4	17.5	4.8	2.6	3.2	1.7	5.3	2.0	1.0	5.5	8.5	1.5
22	10.4	17.5	4.8	2.6	3.2	1.7	3.4	2.0	1.0	6.0	6.5	1.5
23	13.5	17.5	4.8	2.6	2.0	1.2	2.2	20	1.0	6.0	5.0	1.5
24	13.5	8.8	4.8	2.6	1.6	1.2	3.4	8.0	1.5	6.0	5.0	1.5
25	13.5	8.0	12.1	2.6	1.6	1.2	5.3	5.0	1.5	6.0	5.0	1.5
26	13.5	8.0	23	2.0	.7	.5	5.3	1.5	1.5	6.5	5.0	2.5
27	45	8.0	23	2.0	.7	.2	2.7	1.5	1.5	6.5	5.0	2.5
28	30	8.0	10.5	3.0	.7	.2	2.7	1.0	1.5	6.5	5.0	2.5
29	17	......	10.5	3.0	1.6	1.6	2.7	1.0	1.5	6.5	5.0	4.0
30	17	......	5.0	3.0	1.6	4.2	4.3	1.0	1.5	6.5	5.0	4.0
31	21	......	5.0	......	1.6	......	6.7	8.5	......	7.0	......	4.0

Note.—The discharges for 1908–9 were obtained by the indirect method for shifting channels.

Monthly discharge of Mimbres River near Faywood, N. Mex., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1908.					
May	25	6.3	11.6	713	C.
June	15.8	7.8	9.70	577	C.
July	630	10.1	126	7,750	C.
August	1,000	24	124	7,620	C.
September	520	41	63.0	3,750	C.
October	61	28	50.3	3,090	C.
November	44	16	23.9	1,420	D.
December	65	16	30.3	1,860	D.
The period				26,800	
1909.					
January	46	4.4	17.2	1,060	C.
February	21	4.0	9.54	530	C.
March	25	4.8	8.91	548	C.
April	5.0	1.6	3.15	187	C.
May	8.2	.7	2.21	136	C.
June	4.2	.2	1.25	74	C.
July	93	.1	5.92	364	C.
August	108	1.0	11.4	701	D.
September	18	.5	3.57	212	D.
October	7.0	2.0	4.47	275	D.
November	8.5	5.0	6.90	411	D.
December	4.0	1.5	2.26	139	D.
The year	108	.1	6.40	4,640	

CAMERON CREEK BASIN.

CAMERON CREEK AT FORT BAYARD, N. MEX.

This station, which was established on January 17, 1907, at the request of the United States Forest Service, to obtain data concerning flood run-off, is located near the pumping station at Fort Bayard, N. Mex., a United States Army post. The gage, a vertical rod, is a short distance above the crest of an old masonry dam, which was used to check the underflow of the creek.

For the greater part of the year the flow comes from springs, and amounts to less than 1 second-foot. Stephens Creek enters about 2 miles above this station.

The intake for the water supply of the post is above the station, and a little water is also diverted above for garden irrigation. The flood waters of this stream can probably be stored in natural depressions in the vicinity, which will make excellent reservoir sites. These can be supplied by feeder canals.

Ice does not appreciably affect the flow of the stream at this point. The channel has filled up with sediment above the dam, which probably has some effect on low-water measurements. The channel is probably permanent for measurements taken at higher stages. Unfortunately no high-water measurements have yet been made. Measurements are made by wading.

No change has been made in the datum of the gage during the maintenance of the station. Gage observations have been taken gratis by Sergt. T. J. McBurney, U. S. Army.

Discharge meaurements of Cameron Creek at Fort Bayard, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 5	Jas. B. Stewart			1.65	[a]0.6
Feb. 5	do	2.2	1.5	1.70	.3
Apr. 16	do				.5
June 4	do			1.62	.5
July 7	do			1.62	.5
Aug. 8	do			1.32	.5
Oct. 8	W. B. Freeman			1.35	[a].2

[a] Estimated.

NOTE.—Gage heights are distorted by a dam below.

Daily gage height, in feet, and daily discharge, in second-feet, of Cameron Creek at Fort Bayard, N. Mex., for 1909.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
Jan. 1 to June 28	1.45	0.5	July 21-31	1.45	0.5
June 29	1.60	.5	Aug. 1	1.60	.5
June 30-July 2	1.45	.5	Aug. 2-10	1.35	.5
July 3	1.50	.5	Aug. 11	1.70	.5
July 4-12	1.45	.5	Aug. 12-13	1.35	.5
July 13	1.60	.5	Aug. 14	1.6	.5
July 14	1.55	.5	Aug. 15-16	1.35	.5
July 15	1.45	.5	Aug. 17	2.45	96
July 16	1.75	1.0	Aug. 18-20	1.35	.5
July 17	1.45	.5	Aug. 21	2.45	96
July 18	1.75	1.0	Aug. 22-26	1.35	.2
July 19	1.95	8.0	Aug. 27	1.65	.5
July 20	1.55	.5	Aug. 28-Dec. 31	1.35	.2

NOTE.—The gage heights for low stages are not a true index of the discharge.

Monthly discharge of Cameron Creek at Fort Bayard, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	0.5	0.5	0.5	31	D.
February	.5	.5	.5	28	D.
March	.5	.5	.5	31	D.
April	.5	.5	.5	30	D.
May	.5	.5	.5	31	D.
June	.5	.5	.5	30	D.
July	8.0	.5	.77	47	D.
August	96	.2	6.57	404	D.
September	.2	.2	.2	12	D.
October	.2	.2	.2	12	D.
November	.2	.2	.2	12	D.
December	.2	.2	.2	12	D.
The year	96	.2	.93	680	

STEPHENS CREEK NEAR FORT BAYARD, N. MEX.

This station, which was established January 17, 1907, at the request of the United States Forest Service, is located one-fourth mile above the Fort Bayard planting station of the Forest Service, 3 miles north of Fort Bayard.

The records furnish valuable information concerning normal and flood run-off. The station is situated about 2 miles above the junction of this stream with Cameron Creek.

The normal flow of this creek is very small, but for short periods during floods it occasionally carries a large flow, which can probably be stored. The intake for the water supply of the planting station is above the gage.

The records of this station are little, if any, affected by ice.. The results obtained have not been very satisfactory, owing to the small number of discharge measurements, none of which were taken when there was any considerable flow in the stream.

No change has been made in the datum of the gage since the establishment of the station.

Discharge measurements of Stephens Creek near Fort Bayard, N. Mex., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 5	J. B. Stewart	1.30	0.3
Feb. 5	.....do	1.32	.4
Apr. 16	.....do	1.35	.3
July 7	.....do	1.48	.1
Aug. 8	.....do	1.26	.1
Oct. 8	W. B. Freeman	1.25	.01

NOTE.—Discharges are estimated.

Daily gage height, in feet, of Stephens Creek near Fort Bayard, N. Mex., for 1909.

[H. C. Turner, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1								1.50	1.31	1.27		
2								1.60				1.38
3					1.30			1.20		1.25	1.35	
4		1.33	1.30									
5		1.33							1.90	1.25		1.39
6	1.30	1.33			1.30				1.40			
7	1.30						1.48	1.25		1.27		
8		1.33					1.47	1.26			1.35	
9								1.28	1.24			1.40
10					1.35				1.60	1.25		
11								1.60	1.31			
12		1.33	1.45					2.30	2.10	1.25		1.40
13					1.30		2.30					
14	1.30						2.10		1.30	(a)		
15								1.60			1.35	1.40

a Practically dry.

Daily gage height, in feet, of Stephens Creek near Fort Bayard, N. Mex., for 1909—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16							1.90		1.30	1.27		
17								1.80	1.30	1.27		
18		1 34					1.70	1.25				1.40
19									1.30			
20	1.30									1.26	1.36	1.40
21		1.34					1.37	1.60	1.29			
22	1.30							1.40				
23									1.28			
24								1.32		1.26	1.36	1.40
25							1.28	1.32	1.29			
26	1.30	1.34					1.27	1.32				
27							1.27	1.40				1.40
28	1.30											
29					2.00			1.32	1.27	1.27	1.36	
30	1.30											
31										1.27		

PECOS RIVER DRAINAGE BASIN.

DESCRIPTION.

Pecos River, the largest tributary of the Rio Grande, rises on the east side of the Santa Fe Range in northern New Mexico, flows south through eastern New Mexico, then southeast through southwestern Texas, and unites with the Rio Grande about 400 miles (by river) below El Paso. Except for some of the upper tributaries, the branches of the Pecos are intermittent, carrying large floods at times. From source to mouth the river is about 800 miles long, and the total drainage area includes more than 32,000 square miles, of which 23,000 are in New Mexico and 9,000 in Texas.

The upper Pecos flows as a typical mountain stream through narrow valleys and deeply cut gorges, but below Fort Sumner the canyon-like walls are replaced by low rolling hills (see Pl. VI, *B*), and when the river reaches Roswell the gradation from the flood plains to the prairie is imperceptible. Arroyos and gulches are rare, and canyons are practically unknown. The mountain tributaries of the upper Pecos rise at elevations of about 11,000 feet; at Santa Rosa, N. Mex., the elevation is 4,600 feet; at Roswell, 3,500 feet; at Pecos, Tex., 2,550 feet; and at the mouth of the stream it is 1,000 feet.

The main Pecos may be said to be formed by the junction of the Gallinas with the upper Pecos at La Junta, N. Mex. The most important tributaries below this point and above Roswell are the Agua Negra and the Agua Negra Chiquita, which enter just above Puerto de Luna. Except for small springs, no important tributaries enter along this stretch, but some of the dry gulches and arroyos occasionally carry large quantities of flood water. Among the most important of the lower tributaries are the Hondo, Rio Felix, the Penasco, Seven Rivers, and Black River.

It is rather a striking fact that the Pecos receives practically no tributaries from the east, probably because of the pervious character of the soil of the Staked Plains, upon which there is no surface drainage system. The water sinks into limestone rocks and establishes an underground drainage.

The condition of the Pecos basin may be characterized roughly as follows: Merchantable-timber land, 1,300 square miles; woodland, 2,400 square miles; 300 square miles of burnt and cut over land; and the remaining area of about 27,000 square miles is open and sage-brush land.

The rainfall along the Pecos in New Mexico ranges from 20 to 25 inches in the mountainous sections, as above Las Vegas and at Cloudcroft, to about 15 inches in the plains country, or in the vicinity of Roswell and Carlsbad. Through Texas the rainfall is light, the annual average being about 12 inches.

During the winter period the flow of the Pecos is supplied mainly by springs. The river has been known to go dry in the neighborhood of Colonias, N. Mex.

Considerable ice forms on the upper Pecos, and heavy snows are common. In the vicinity of Santa Rosa and Fort Sumner thin ice and slush ice are in evidence during a part of the winter. Lower down the valley there is an occasional light snow, which disappears very quickly, and at times there is thin ice along the edges of the river. In the lower end of the valley the climate is mild. The rainfall comes mainly in the summer months, in the form of showers, and is variable and uncertain.

Irrigation in New Mexico has reached its highest stage of development in the lower Pecos Valley, the irrigated district beginning a short distance above Roswell and continuing into Texas. Thousands of acres are under cultivation, and a wise and economical system of reservoirs and canals is in force. The surface waters have been greatly augmented during the past few years by numerous artesian wells. Above this fertile belt comparatively little farming is engaged in; below it irrigation is carried on only in a small way, as the return seepage water contains, unfortunately, a great percentage of alkali, which renders it undesirable for irrigation.

The recently completed Carlsbad and Hondo projects (Pl. IV, *B*) of the Reclamation Service provide for the irrigation of 20,000 and 10,000 acres, respectively, while the proposed Urton Lake project, which is to be relinquished by the Reclamation Service in favor of a Carey Act project, will result in the irrigation of about 60,000 acres in the vicinity of old Fort Sumner, N. Mex.

Numerous reservoir sites are to be found along the Pecos and its tributaries. Among the reservoirs now in operation may be mentioned Lake McMillan on the Pecos, and the Hondo reservoir on Hondo River. Urton Lake, a natural depression in the vicinity of Fort Sumner, will have a storage capacity of 190,000 acre-feet. It is to be supplied by a feeder canal from Pecos River. Because of the large amount of silt carried by this stream the prevention of its deposition must be taken into account and provided for in the construction of reservoirs.

On account of its long periods of low water, this stream does not offer many favorable opportunities for the development of power. At present there are no water-power plants of any importance in operation in the basin, except a public-utility plant of about 300 horsepower at Carlsbad, N. Mex. Later there may be some power development in connection with irrigation projects.

The records along this stream are very fragmentary, and most of them were taken within the last five or six years. From them it would appear that 1903 was a very low year and 1905 an unusually high one.

PECOS RIVER NEAR FORT SUMNER, N. MEX.

The station, which was established on June 12, 1904, to determine the amount of water available for the Urton Lake project of the United States Reclamation Service, is located at a place known as Arinosa, about 12 miles northwest of old Fort Sumner, N. Mex., and 4 miles upstream from Fort Sumner, a station on the Belen cut-off of the Atchison, Topeka & Santa Fe Railway, and is near the site of the proposed diversion dam and a few miles below Arroyo Salada. The nearest post-office is Fort Sumner.

All the tributaries for a long distance above and below the station are intermittent in character and only occasionally carry large amounts of water. The drainage area above the station is about 5,300 square miles.

Some irrigation is practiced along the bottom lands at various localities above the station, but not enough to materially affect the flow of the stream. The proposed Urton Lake project will divert a considerable portion of the stream flow at this point.

Slush ice sometimes forms at this station, and thin ice forms along the edges of the river, but results are not greatly affected by the ice conditions.

On July 5, 1905, the station was moved downstream and a new rod gage established at the present datum. Otherwise there had been no change in datum.

On account of the extremely shifting character of the channel, it is impossible to make reliable estimates of discharge unless very frequent measurements are made. High-water measurements are made from a cable.

Discharge measurements of Pecos River near Fort Sumner, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 29	J. B. Stewart	92	58	2.20	91
Apr. 14	.....do	46	38	2.25	70
June 1	.....do	72	59	2.52	126
June 30	.....do	96	55	2.33	66
July 20	W. H. Sutton	33	60	2.05	89
Aug. 25	.....do	220	177	2.45	389
Sept. 5	J. B. Stewart	209	161	2.70	400
Oct. 20	W. B. Freeman	106	63	2.46	95
Dec. 7	G. H. Russell	111	64	2.76	50

NOTE.—Measurements made at various sections.

Daily gage height, in feet, of Pecos River near Fort Sumner, N. Mex., for 1909.

[J. C. Pacheco, observer.]

Day.	Jan.	Feb.	Mar	Apr.	May.	June.	July	Aug.	Sept	Oct.	Nov.	Dec.
1	2.35	2.3	2.25	2.35	2.3	2.5	2.7	2.2	2.7	2.3	2.4	2.5
2	2.3	2.35	2.25	2.3	2.3	2.5	2.4	2.3	2.5	2.3	2.4	2.5
3	2.35	2.3	2.25	2.3	2.35	2.4	2.4	2.2	2.5	2.3	2.45	2.5
4	2.3	2.35	2.3	2.3	2.4	2.45	2.3	2.3	2.55	2.35	2.4	2.5
5	2.3	2.3	2.2	2.3	2.4	2.35	2.4	2.3	2.6	2.35	2.45	2.55
6	2.3	2.35	2.25	2.35	2.35	2.4	2.4	2.25	3.2	2.3	2.45	2.5
7	2.3	2.3	2.25	2.35	2.3	2.4	2.4	2.3	3.3	2.4	2.5	2.75
8	2.25	2.3	2.25	2.35	2.3	2.4	2.45	2.55	3.05	2.5	2.5	2.7
9	2.25	2.35	2.2	2.35	2.4	2.55	2.6	2.4	2.9	2.4	2.45	2.6
10	2.3	2.35	2.35	2.3	2.5	2.5	2.7	2.4	2.75	2.5	2.5	2.55
11	2.25	2.35	2.5	2.35	2.5	2.5	2.5	2.3	2.8	2.5	2.45	2.5
12	2.35	2.3	2.45	2.3	2.4	2.5	2.4	2.65	2.8	2.4	2.4	2.55
13	2.45	2.3	2.4	2.3	2.4	2.7	2.35	3.00	2.8	2.4	2.4	2.5
14	2.5	2.35	2.3	2.3	2.4	2.5	2.3	2.50	2.6	2.45	2.45	2.55
15	2.4	2.5	2.3	2.2	2.35	2.5	3.25	2.4	2.6	2.4	2.45	2.55
16	2.3	2.4	2.3	2.3	2.3	2.55	2.7	2.95	2.5	2.4	2.45	2.6
17	2.3	2.3	2.3	2.3	2.4	2.6	2.3	2.8	2.6	2.4	2.4	2.6
18	2.2	2.3	2.25	2.35	2.5	2.5	2.25	2.5	2.55	2.4	2.4	2.6
19	2.25	2.3	2.25	2.3	2.4	2.5	2.1	2.5	2.6	2.4	2.45	2.6
20	2.2	2.3	2.25	2.3	2.5	2.5	2.2	2.5	2.6	2.45	2.45	2.6
21	2.25	2.3	2.3	2.5	2.65	2.4	2.1	2.9	2.5	2.5	2.45	2.6
22	2.3	2.35	2.3	2.4	2.65	2.4	2.0	3.2	2.5	2.45	2.45	2.85
23	2.25	2.3	2.25	2.4	2.7	2.4	2.0	2.6	2.45	2.4	2.45	2.9
24	2.35	2.35	2.2	2.4	2.45	2.5	2.8	2.5	2.4	2.4	2.45	2.9
25	2.3	2.3	2.3	2.45	2.4	2.4	2.6	2.6	2.4	2.45	2.45	2.85
26	2.25	2.3	2.3	2.45	2.5	2.3	2.7	2.6	2.4	2.4	2.5	2.7
27	2.25	2.3	2.3	2.45	2.5	2.35	2.3	2.7	2.4	2.4	2.45	2.8
28	2.2	2.3	2.3	2.4	2.5	2.35	2.	2.7	2.4	2.4	2.55	2.8
29	2.3	....	2.35	2.35	2.4	2.4	2.2	2.8	2.3	2.4	2.5	2.7
30	2.3	....	2.3	2.3	2.4	2.35	2.1	2.8	2.3	2.4	2.5	2.6
31	2.3	....	2.35	....	2.45	....	2.2	2.8	....	2.4	....	2.3

Daily discharge, in second-feet, of Pecos River near Fort Sumner, N. Mex., for 1908-9.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	195	30	100	135	285	160	245	390	160	60	78	185
2	195	45	75	135	285	187	167	920	105	60	97	155
3	200	82	125	167	205	225	495	1,020	160	60	97	155
4	200	135	125	135	205	187	165	810	385	60	97	125
5	240	85	125	135	205	160	110	725	158	58	78	155
6	200	65	125	137	282	160	85	630	158	58	97	125
7	205	65	150	137	282	127	65	630	84	58	97	105
8	170	65	150	137	200	155	85	1,360	68	87	78	125
9	145	65	125	172	200	185	85	1,150	42	87	78	125
10	145	65	150	172	200	127	85	420	53	87	78	165
11	145	65	125	140	167	127	110	265	42	105	80	125
12	145	85	125	140	167	155	110	265	42	86	80	125
13	145	70	125	140	200	97	105	360	42	86	98	160
14	95	90	155	115	282	97	105	1,150	40	86	98	125
15	75	70	155	115	282	97	157	1,360	40	86	98	125
16	75	70	102	140	240	97	130	545	65	85	100	87
17	40	50	127	140	240	125	222	465	51	85	100	87
18	25	50	105	140	240	125	222	465	64	85	100	107
19	25	90	105	287	240	97	950	465	38	65	82	87
20	25	90	80	287	195	75	222	475	78	80	82	107
21	25	95	105	287	195	75	530	6,500	65	80	100	107
22	25	70	105	287	235	75	410	1,600	38	80	100	87
23	25	120	105	285	960	75	300	1,750	38	100	100	130
24	25	145	160	245	190	52	300	460	65	100	100	130
25	40	145	105	205	230	52	300	45	75	80	83	130
26	25	120	80	285	190	70	300	60	60	100	103	130
27	25	120	80	440	190	70	395	60	93	80	103	165
28	25	75	110	385	270	245	395	245	93	80	103	130
29	25	100	110	285	227	245	295	245	93	78	103	165
30	30	....	110	285	187	245	735	340	60	78	125	165
31	30	....	135	....	187	....	510	45	....	78	....	165
1909.												
1	165	137	95	115	75	116	295	168	485	63	48	14
2	130	170	95	95	72	118	92	246	250	63	42	14
3	165	137	95	95	87	78	110	168	230	60	53	12
4	130	170	120	95	107	95	72	246	245	75	37	12
5	130	137	73	92	105	68	130	246	295	73	48	15
6	135	170	90	110	83	77	130	204	1,240	55	46	11
7	135	135	90	110	69	77	145	246	1,480	85	58	50
8	110	135	90	110	67	80	190	514	920	127	53	37
9	110	168	73	110	97	148	345	340	660	85	38	20
10	137	168	135	90	150	127	500	340	440	127	48	15
11	110	168	250	108	150	127	285	246	510	127	35	12
12	170	130	205	88	95	127	215	662	500	80	28	16
13	250	130	162	88	95	280	183	1,370	495	80	25	13
14	310	168	110	87	95	127	175	452	265	103	29	17
15	210	290	110	55	75	127	1,620	340	265	80	27	18
16	137	205	105	85	60	161	660	1,250	180	77	27	25
17	137	135	105	85	90	195	210	934	260	76	19	26
18	90	128	84	102	130	127	190	452	200	75	17	27
19	112	128	84	85	85	127	108	452	255	75	22	28
20	90	125	84	82	127	127	175	452	250	90	20	29
21	112	125	103	190	237	85	110	1,140	170	112	19	30
22	137	150	103	122	237	85	73	1,860	165	85	17	100
23	112	125	80	120	280	85	73	587	133	65	16	120
24	170	150	65	117	105	133	934	452	105	65	15	120
25	137	120	100	147	85	87	587	587	103	75	13	103
26	112	120	100	147	120	65	750	555	103	60	20	55
27	112	118	100	143	120	70	246	670	100	57	12	88
28	91	118	100	115	120	70	73	635	100	55	23	87
29	137	....	117	92	80	88	168	750	64	53	16	60
30	137	....	95	75	80	72	110	705	64	50	15	37
31	137	....	117	....	95	....	168	670	....	48	....	7

Note.—Discharges for 1908-9 were obtained by the indirect method for shifting channels.

Monthly discharge of Pecos River near Fort Sumner, N. Mex., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
January	240	25	96.5	5.930
February	145	30	83.5	4,800
March	160	75	121	7,440
April	440	115	203	12,100
May	960	167	247	15.200
June	245	52	132	7,860
July	950	65	271	16,700
August	a 6,500	45	814	50,100
September	385	38	85.2	5,070
October	105	58	79.3	4,880
November	125	78	93.8	5.580
December	185	87	131	8.060
The year	6,500	25	196	144.000
1909.				
January	310	91	141	8,670
February	290	118	149	8.280
March	250	65	108	6.640
April	190	55	105	6,250
May	280	60	112	6.890
June	280	65	112	6,660
July	1,620	72	294	18,100
August	1,860	168	579	35.600
September	1,480	64	351	20,900
October	127	48	77.5	4,770
November	58	12	29.5	1.760
December	120	7	39.3	2.420
The year	1,860	7	175	127,000

a Estimated.

NOTE.—The above estimates are in general only approximate.

PECOS RIVER NEAR DAYTON, N. MEX.

This station, which was established March 24, 1905, has been maintained in connection with the Carlsbad irrigation project in New Mexico to determine the amount of water supplied by the river to the McMillan reservoir, and is located about 3 miles east of Dayton, N. Mex., about 6 miles above the dam of the reservoir, and approximately 100 feet downstream from the mouth of Penasco River.

The original rod gage was washed out on September 6, 1905, and was relocated September 7, 1905, at a point about one-half mile upstream. Otherwise there has been no change in gage datum. Fair results can be obtained at this station if discharge measurements are taken at frequent intervals. This station was transferred March 31, 1908, to the United States Reclamation Service, and since then they have made the discharge measurements. Discharge measurements are made from a cable located about 100 yards below the new gage.

Considerable irrigation is practiced in the vicinity of Roswell, N. Mex., and opportunities for irrigation projects exist at various points above. The winters in this vicinity are comparatively mild and ice does not appreciably affect stream flow.

Discharge measurements of Pecos River near Dayton, N. Mex., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
June 24	U. S. Reclamation Service	2.95	80
June 28	do	2.6	40
June 29	do	4.4	456
July 8	do	3.8	244
July 19	do	4.0	280
July 27	do	(a)	1,080
Aug. 3	do	2.6	100
Aug. 14	do	2.4	72
Nov. 3	do	2.75	112
Dec. 11	do	3.7	291

a Gage washed out.

Daily gage height, in feet, of Pecos River near Dayton, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	3.6	3.0	2.8	2.8	2.8	3.8	....	3.9	2.6	2.7	3.0
2	3.7	3.9	3.0	2.8	2.8	2.7	3.6	....	3.8	2.6	2.7	3.0
3	3.8	3.7	3.0	2.9	2.7	2.6	3.4	2.6	3.5	2.6	2.7	3.0
4	3.7	3.6	3.0	2.9	2.7	2.5	3.2	2.6	3.3	2.5	2.7	3.0
5	4.0	3.6	2.9	2.8	2.5	2.6	3.2	2.5	3.3	2.5	2.7	3.0
6	4.2	3.5	2.9	2.8	2.4	2.6	3.4	2.5	3.2	2.5	2.7	3.0
7	4.0	3.5	2.9	2.8	2.4	2.6	3.4	2.4	3.0	2.6	2.7	3.8
8	3.9	3.6	2.9	2.9	2.4	2.5	4.0	2.3	2.9	2.6	2.7	3.7
9	3.8	3.6	2.9	2.9	2.4	2.5	3.4	2.4	7.4	2.6	2.7	3.6
10	3.8	3.6	2.9	2.6	2.4	2.5	3.1	2.3	5.2	2.5	2.7	3.6
11	3.8	3.5	2.9	2.6	2.4	2.5	3.0	2.6	4.9	2.5	2.7	3.6
12	3.8	3.5	3.0	2.5	2.4	2.5	3.8	2.4	4.6	2.5	2.7	3.6
13	3.7	3.5	3.0	2.5	2.3	2.5	3.7	2.3	4.6	2.5	2.8	3.6
14	3.8	3.4	3.1	2.5	2.3	3.7	2.6	2.5	4.7	2.5	2.8	3.6
15	3.8	3.4	3.2	2.5	2.3	3.2	2.5	2.7	4.7	3.0	4.0	3.9
16	3.8	3.4	3.3	2.5	2.3	4.2	3.0	2.8	3.1	3.0	3.9	3.8
17	3.9	3.4	3.3	2.4	3.0	4.2	2.9	3.0	4.0	3.0	3.2	3.9
18	5.0	3.4	3.7	2.4	3.0	3.9	4.4	3.0	3.7	3.0	2.8	4.0
19	4.1	3.4	3.6	2.5	2.7	3.7	4.0	3.0	3.7	3.0	2.8	4.0
20	4.0	3.4	3.6	2.5	2.7	3.4	3.6	3.8	3.5	3.2	2.8	4.0
21	4.0	3.4	3.4	2.3	2.8	3.2	3.4	3.6	3.3	3.1	2.8	4.0
22	4.0	3.4	3.3	2.3	2.8	3.2	3.2	4.2	3.2	3.0	2.8	4.0
23	3.8	3.3	3.2	2.4	2.9	3.1	3.0	3.6	3.0	3.2	2.8	4.4
24	4.0	3.2	3.2	2.3	2.9	2.95	3.1	3.4	3.0	3.2	2.8	4.4
25	3.8	3.2	3.2	2.5	2.9	2.9	5.5	4.0	2.9	3.2	3.2	5.3
26	3.8	3.0	3.0	2.4	2.9	2.7	....	3.7	2.8	3.0	3.0	3.9
27	3.9	3.0	2.9	2.4	2.3	2.5	....	3.5	2.7	2.7	3.0	3.7
28	3.9	3.0	2.9	3.2	3.4	2.5	....	3.4	2.8	2.7	3.0	3.7
29	3.6	....	2.9	3.0	3.2	3.5	....	3.7	2.8	2.7	3.0	3.6
30	3.6	....	2.9	2.9	3.0	3.9	....	3.7	2.6	2.6	3.0	4.4
31	3.6	....	2.9	....	2.9	....	....	3.9	....	2.7	....	4.1

Note.—Gage washed out July 26 and replaced August 3.

Daily discharge, in second-feet, of Pecos River near Dayton, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	260	230	85	60	60	60	236	....	370	90	100	135
2	260	340	85	60	60	48	190	....	330	90	100	135
3	300	260	85	72	48	40	151	90	230	90	100	135
4	260	230	85	72	48	36	115	90	186	82	100	135
5	385	230	70	60	36	40	115	82	186	82	100	135
6	490	200	70	60	32	40	151	82	167	82	100	135
7	385	200	70	60	32	40	151	74	135	90	100	330
8	340	230	70	72	32	36	290	67	122	90	100	290
9	300	230	70	72	32	36	151	74	4,200	90	100	260
10	300	230	70	40	32	36	99	67	1,340	82	100	260

Daily discharge, in second-feet, of Pecos River near Dayton, N. Mex., for 1909—Contd.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	300	200	70	40	32	36	85	90	1,040	82	100	260
12	300	230	85	36	32	36	236	74	790	82	100	260
13	260	230	85	36	30	36	212	67	790	82	110	260
14	300	170	105	36	30	212	40	82	870	82	110	260
15	300	170	125	36	30	115	36	100	870	135	420	370
16	300	170	145	36	30	360	85	110	150	135	370	330
17	340	170	145	32	85	360	72	135	420	135	167	370
18	1,080	170	260	32	85	262	450	135	290	135	110	420
19	440	170	230	36	48	212	290	135	290	135	110	420
20	385	170	230	36	48	151	190	330	230	167	110	420
21	385	170	170	30	60	115	151	260	186	150	110	420
22	385	170	145	30	60	115	115	530	167	135	110	420
23	300	145	125	32	72	99	85	260	135	167	110	650
24	385	125	125	30	72	78	99	207	135	167	110	650
25	300	125	125	36	72	72	1,290	420	122	167	167	1,440
26	300	85	85	32	72	48	....	290	110	135	135	370
27	340	85	70	32	30	36	....	230	100	100	135	290
28	340	85	70	115	151	36	....	207	110	100	135	290
29	230	....	70	85	115	170	....	290	110	100	135	260
30	230	....	70	72	85	262	....	290	90	90	135	650
31	230	....	70	....	72	....	....	370	....	100	....	470

NOTE.—Discharges January 1 to March 31 obtained by indirect method for shifting channels. Discharges April 1 to July 25 are based on a rating curve that is well defined below 510 second-feet. Discharges August 3 to December 31 are based on a rating curve that is fairly well defined below 400 second-feet.

Monthly discharge of Pecos River near Dayton, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	1,080	230	345	21,200	C.
February	340	85	186	10,300	C.
March	260	70	109	6,700	C.
April	115	30	49.3	2,930	C.
May	151	30	55.6	3,420	C.
June	360	36	107	6,370	A.
July 1-25	1,290	36	203	10,100	A.
August 3-31	530	67	181	10,400	A.
September	4,200	90	476	28,300	B.
October	167	82	111	6,820	B.
November	420	100	133	7,910	B.
December	1,440	135	362	22,300	B.
The period	....	....	....	137,000	

PECOS RIVER NEAR LAKEWOOD, N. MEX.

The station, which was established January 11, 1906, and transferred to the United States Reclamation Service March 31, 1908, is located 3 miles southeast of Lakewood and one-half mile below the McMillan reservoir dam.

The present inclined rod gage was established May 8, 1906. It had been previously moved from original location on February 8, 1906.

Fair results can be obtained at this station if occasional discharge measurements are made at different stages. Discharge measurements are made from a cable located about one-fourth mile above the railroad bridge of the Eastern Railway of New Mexico.

Discharge measurements of Pecos River near Lakewood, N. Mex., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
July 12	U. S. Reclamation Service	1.0	97
Do	do	1.2	143
Do	do	1.55	209
July 27	do	3.0	625
Sept. 23	do	3.9	1,230
Do	do	1.9	381
Do	do	.8	89

Daily gage height, in feet, of Pecos River near Lakewood, N. Mex., for 1909.

[H. C. Holcomb, observer.]

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1		1.4	0.8	0.7	0.6	0.65	0.8	1.5	0.8
2		1.4	.8	.7	.6	.7	.8	1.5	.8
3		1.4	.8	.7	.6	.7	.8	1.5	.8
4		1.4	.8	.7	.6	.9	.8	1.5	.8
5			.8	1.2	.6	.9	.8	1.5	.8
6			.8	1.2	.6	.9	.8	1.5	.8
7			.8	1.2	.65	.9	.8	1 5	.8
8			.8	1.2	.5	.9	.8	1.5	.8
9			.8	1.2	.5	.9	.8	1.5	.8
10			.8	1.1	.5	.9	.8	1.5	.8
11			.8	.95	.5	1.0	8	3.15	.8
12			.8	.8	.5	.8	.8	4.5	.8
13			.8	.8	.5	.8	.8	4.3	.7
14			.8	.75	.5	.8	.8	4.2	.6
15			.8	.7	.75	1.35	.8	1.95	.6
16			.8	.7	1.2	1.4	.8	1.5	2.7
17			.8	.7	.6	1.3	.8	1.5	4.0
18			.8	.7	.6	1.35	.8	1.5	.85
19			.75	.7	.6	1.3	.8	1.5	.85
20		1.4	.7	.7	.6	1.3	.8	1.25	
21		1.4	.7	.7	.6	1.3	.8	1.0	
22		1.4	.7	.7	.6	1.25	1.1	1.0	
23		1.4	.7	.7	.6	1.2	1.4	1.5	
24	1.4	1.4	.7	.7	.6	1.2	1.4	.8	
25	1.4	1.4	.7	.7	.6	2.7	1.4	.8	
26	1.4	1.4	.7	.95	.6	4.4	1.4	.8	
27	1.4	.8	.7	1.2	.6	3.1	1.4	.8	
28	1.4	.8	.7	1.2	.6	1.3	1.4	.8	
29		.8	.7	1.2	.6	.8	1.4	.8	
30		.8	.7	1.2	.6	.8	1.5	.8	
31		.8		.8		.8	1.5		

NOTE.—River probably dry January 1 to February 23 and October 20 to December 31.

Daily discharge, in second-feet, of Pecos River near Lakewood, N. Mex., for 1909.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	....	178	64	50	36	43	68	292	89
2	....	178	64	50	36	50	69	295	89
3	....	178	64	50	36	50	70	297	89
4	....	178	64	50	36	80	71	300	89
5	....	178	64	136	36	80	72	302	89
6	....	178	64	136	36	80	74	305	89
7	....	178	64	136	43	80	75	307	89
8	....	178	64	136	24	80	77	310	89
9	....	178	64	136	24	80	80	315	89
10	....	178	64	116	24	80	82	318	89
11	....	178	64	88	24	97	85	889	89
12	....	178	64	64	24	64	87	1,520	89
13	....	178	64	64	24	64	91	1,420	71
14	....	178	64	57	24	64	94	1,380	54
15	....	178	64	50	57	168	96	399	54
16	....	178	64	50	136	178	99	250	690
17	....	178	64	50	36	157	101	250	1,280
18	....	178	64	50	36	168	104	250	98
19	....	178	57	50	36	157	106	250	98
20	....	178	50	50	36	157	109	184	....
21	....	178	50	50	36	157	111	128	....
22	....	178	50	50	36	146	180	128	....
23	....	178	50	50	36	136	241	250	....
24	178	178	50	50	36	136	244	89	....
25	178	178	50	50	36	524	247	89	....
26	178	178	50	88	36	1,280	250	89	....
27	178	64	50	136	36	662	252	89	....
28	178	64	50	136	36	157	255	89	....
29	....	61	50	136	36	65	258	89	....
30	....	64	50	136	36	66	287	89	....
31	....	64	....	64	....	67	290	....	....

NOTE.—These discharges were obtained as follows:
February 24 to July 28 from a rating curve which is fairly well defined between 80 and 830 second-feet.
July 29 to September 10 by indirect method for shifting channels.
September 11 to October 19 from a rating curve which is fairly well defined.
March 5-19 interpolated.
Although the observer gives no definite dates, it is probable that the river was dry January 1 to February 23 and October 20 to December 31.

Monthly discharge of Pecos River near Lakewood, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	0	0	0	0	
February	178	0	31.8	1,770	C.
March	178	64	160	9,840	C.
April	64	50	58.6	3,490	C.
May	136	50	81.1	4,990	B.
June	136	24	37.5	2,230	C.
July	1,280	43	173	10,600	B.
August	290	68	140	8,610	B.
September	1,520	89	365	21,700	A.
October	1,280	0	110	6,760	B.
November	0	0	0	0	
December	0	0	0	0	
The year	1,520	0	96.4	70,000	

PECOS RIVER NEAR MOORHEAD, TEX.

The station, which was established by the International Boundary Commission in April, 1900, is near Moorhead, immediately above the high bridge of the Southern Pacific Railroad.

The station is in the bottom of a canyon about 300 feet deep. Both banks are of rock, but the bottom of the stream is mud. The river here consists of a series of pools connected by rapids. The best pool was chosen for the station. Frequent discharge measurements are made to determine closely the daily discharge. The highest known flood occurred April 6, 1900, about two weeks before this gage was established. The water marks showed that it reached 35.75 feet on the gage.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Pecos River near Moorhead, Tex., in 1909.

[By E. E. Winter.

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	701	1.0	417	July 9	675	0.5	178
8	713	1.0	433	13	676	.5	184
13	701	1.0	427	17	669	.4	185
19	707	1.1	447	21	684	.55	213
24	690	1.0	401	26	898	2.55	1,313
29	683	1.0	403	29	909	2.65	1,401
Feb. 3	689	1.0	384	Aug. 4	837	1.8	978
8	678	.95	355	9	702	.9	371
13	673	.95	342	13	733	1.0	395
18	686	.8	289	17	698	.8	359
22	686	.8	301	22	690	.65	266
26	683	.75	288	25	683	.6	256
Mar. 3	672	.85	306	29	698	.7	284
8	680	.85	318	Sept. 3	688	.5	229
13	672	.8	293	7	685	.5	229
18	654	.7	242	14	679	.5	247
23	672	.85	308	18	676	.5	235
29	649	.7	271	22	867	2.1	1,094
Apr. 4	671	.8	239	28	686	.75	329
9	637	.7	231	Oct. 4	691	.8	290
14	676	.8	276	8	687	.8	295
19	646	.7	239	12	671	.7	251
23	637	.65	224	16	669	.5	229
28	680	.8	293	21	695	.7	280
May 3	656	.6	246	25	696	.7	292
7	646	.6	258	29	702	.8	293
11	642	.5	228	Nov. 4	684	.7	269
15	654	.55	234	8	681	.7	273
19	656	.7	255	12	687	.8	322
24	736	1.1	431	16	688	.8	311
29	675	.5	228	21	700	.8	315
June 3	675	.5	229	25	705	.9	343
7	663	.4	178	28	704	.9	341
11	656	.4	181	Dec. 6	707	.9	361
16	674	.8	267	10	705	.9	381
20	681	.55	242	15	711	.9	377
24	836	1.7	822	20	720	1.0	391
28	692	.5	229	26	729	1.0	388
July 3	688	.55	196	31	739	1.05	426

Daily gage height, in feet, of Pecos River near Moorhead, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.0	0.85	0.7	0.7	0.55	0.65	3.4	0.7	0.9	0.85	0.9
2	1.0	1.0	.85	.75	.6	.75	.65	3.35	.6	.85	.8	.9
3	1.0	1.0	.85	.8	.6	.5	.55	2.4	.5	.8	.8	.9
4	1.0	1.0	.85	.8	.65	.65	.6	1.85	.5	.8	.7	.85
5	1.0	1.0	.8	.7	.7	.6	.7	1.6	.55	.8	.7	.9
6	1.0	.95	.8	.7	.6	.6	.65	1.4	.55	.8	.75	.9
7	1.0	.95	.85	.7	.6	.45	.6	1.0	.5	.8	.75	.9
8	1.0	.95	.85	.7	.6	.55	.55	.95	.5	.8	.7	.9
9	1.0	.95	.85	.7	.6	.4	.5	.9	.5	.8	.7	.9
10	1.0	.95	.9	.7	.6	.45	.45	.9	.5	.75	.7	.9
11	1.0	.95	.9	.7	.5	.4	.4	.95	.5	.75	.7	.9
12	1.0	.95	.8	.7	.5	.45	.5	1.0	.55	.7	.75	.9
13	1.0	.95	.8	.7	.55	.45	.5	1.0	.6	.7	.8	.9
14	1.0	.9	.8	.8	.55	.4	.45	1.1	.5	.6	.8	.9
15	1.0	.8	.8	.8	.55	1.5	.45	.85	.6	.55	.8	.9
16	1.05	.8	.8	.8	.6	.85	.4	.85	.6	.5	.8	.95
17	1.1	.8	.7	.8	.7	.75	.4	.8	.5	.5	.85	1.0
18	1.1	.8	.7	.75	.7	.7	.5	.7	.5	.6	.9	1.0
19	1.1	.85	.75	.7	.7	.7	.5	.8	.5	.6	.9	1.0
20	1.1	.9	.8	.7	.65	.55	.5	.7	1.0	.65	.8	1.0
21	1.1	.9	.8	.7	.65	.5	.5	.65	2.75	.7	.8	1.0
22	1.1	.8	.8	.65	.65	.4	.6	.7	2.2	.65	.8	1.0
23	1.1	.8	.85	.65	.9	.7	.7	.7	1.8	.65	.85	1.0
24	1.0	.8	.85	.6	1.05	1.5	.7	.7	1.25	.7	.85	1.0
25	1.1	.75	.8	.55	1.65	1.85	2.85	.65	1.0	.7	.9	1.0
26	1.1	.75	.8	.55	1.85	.9	2.6	.65	1.0	.7	.95	1.0
27	1.0	.85	.75	.8	1.35	.65	.75	.7	1.0	.75	.9	1.0
28	1.0	.85	.75	.8	.85	.55	.6	.7	.85	.8	.9	1.0
29	1.0	....	.75	.75	.55	.55	2.0	.7	.8	.8	.95	1.0
30	1.0	....	.7	.6	.5	.5	2.2	.8	.75	.8	.95	1.0
31	1.0	....	.7	....	.5	....	3.0	.75	....	.85	....	1.05

Daily discharge, in second-feet, of Pecos River near Moorhead, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	380	395	305	255	270	245	245	1,780	285	375	310	350
2	400	390	305	255	240	305	235	1,750	260	340	295	350
3	[a] 415	[a] 385	[a] 305	255	[a] 245	[a] 230	[a] 195	1,280	[a] 230	305	295	355
4	420	380	310	[a] 240	265	305	215	[a] 1,000	230	[a] 290	[a] 270	340
5	425	375	295	230	295	280	250	845	245	290	270	360
6	425	360	300	230	270	280	230	710	245	290	285	[a] 360
7	430	355	315	230	[a] 260	[a] 205	215	435	[a] 230	295	290	365
8	[a] 430	[a] 355	[a] 320	230	260	225	195	405	230	[a] 295	[a] 275	370
9	430	355	320	[a] 230	255	180	[a] 180	[a] 370	235	295	275	375
10	430	350	345	235	250	195	165	370	240	270	275	[a] 380
11	430	350	345	240	[a] 230	[a] 180	150	385	240	270	275	380
12	425	345	295	245	230	190	185	395	260	[a] 250	[a] 300	380
13	[a] 425	[a] 340	[a] 295	250	235	190	[a] 185	[a] 395	275	250	320	380
14	425	325	295	[a] 275	235	180	175	415	[a] 245	240	315	380
15	425	290	295	275	[a] 235	560	185	370	275	235	315	[a] 375
16	435	290	295	275	240	[a] 280	180	370	270	[a] 230	[a] 310	380
17	445	290	245	275	255	265	[a] 185	[a] 360	240	230	325	390
18	445	[a] 290	[a] 240	255	255	260	205	320	[a] 235	260	340	390
19	[a] 445	310	265	[a] 240	[a] 255	260	205	340	235	260	340	390
20	445	330	285	240	235	[a] 245	205	300	505	275	315	[a] 390
21	440	330	285	240	235	230	[a] 205	275	1,440	[a] 290	[a] 315	390
22	435	[a] 300	285	225	235	200	240	[a] 280	[a] 1,140	275	315	390
23	430	300	[a] 310	[a] 225	345	345	295	275	925	275	330	390
24	[a] 400	300	310	210	[a] 410	[a] 730	295	275	610	290	330	390
25	440	290	295	195	620	895	1,480	[a] 265	470	[a] 290	[a] 345	390
26	440	[a] 290	295	195	685	430	[a] 1,340	270	470	285	360	[a] 390
27	410	305	285	295	515	310	415	285	470	295	345	390
28	410	305	285	[a] 295	345	[a] 260	340	285	[a] 385	300	[a] 340	395
29	[a] 405	....	[a] 285	280	[a] 245	235	[a] 1,070	[a] 285	350	[a] 295	360	400
30	405	....	270	235	230	210	1,190	315	330	295	360	405
31	405	....	270	....	230	....	1,590	300	....	310	....	[a] 425

[a] Date of measurement.

Monthly discharge of Pecos River near Moorhead, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	445	380	424	26,083
February	395	290	331	18,407
March	345	240	295	18,149
April	295	195	245	14,588
May	685	230	294	18,069
June	895	180	297	17,663
July	1,580	150	401	24,645
August	1,780	265	507	31,150
September	1,440	230	393	23,405
October	375	230	282	17,346
November	360	270	313	18,634
December	425	340	380	23,395
The year	1,780	150	347	251,534

GALLINAS RIVER NEAR LAS VEGAS, N. MEX.

The station, which was established August 13, 1903, and maintained primarily for the purpose of determining the amount of water available for diversion and storage in the San Guyjella basin about 6 miles northwest of Las Vegas, is located at Los Vegas Hot Springs, 6 miles above Las Vegas, N. Mex.

The altitude of the station is about 6,700 feet. It is below all perennial tributaries. The drainage area above the station is about 90 square miles; the total drainage area exceeds 600 square miles.

Very little water is diverted above the station, though practically all of the ordinary flow is used for irrigation in the valley below. The reservoir mentioned above has a capacity of about 40,000 acre-feet, and is to be used for the irrigation of 10,000 acres of land. It will be filled from the Gallinas, the Sapello, and other small streams in that vicinity. The flow of the stream at this point is not usually affected by it.

The gage was washed out on September 29, 1904, and replaced by the present rod gage on October 19, 1904, which is located about 600 feet above the foot-bridge at the power house, from which high discharge measurements are made. Lower water measurements are made by wading. The zero of the new rod gage is 0.71 foot lower than that of the old one. Results at this station have been fairly satisfactory.

Discharge measurements of Gallinas River near Las Vegas, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 20	J. B. Stewart	17	7	1.75	3.1
Apr. 5	do	24	18.5	2.00	18.7
May 22	do	24	17	2.05	19.7
June 24	do	6	1.3	1.70	1.0
July 28	W. H. Sutton	22	22	1.88	14.1
Aug. 29	do	16	20.8	2.20	35.0
Oct 26	W. B. Freeman	17	9.6	1.68	1.7
Nov. 29	G. H. Russell	18.5	11.4	1.77	4.3

Daily gage height, in feet, of Gallinas River near Las Vegas, N. Mex., for 1909.

[Wm. Prager, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.8	1.8	1.75	1.9	2.1	2.0	1.7	1.8	2.05	1.5	1.6	1.8
2	1.8	1.8	1.9	1.8	2.1	2.0	1.7	1.8	2.05	1.5	1.65	1.8
3	1.8	1.8	1.85	1.85	2.1	1.95	1.7	1.85	2.05	1.5	1.8	1.8
4	1.8	1.8	1.9	2.1	2.1	1.95	1.75	1.9	2.2	1.5	1.8	1.8
5	1.8	1.8	1.85	2.05	2.1	1.9	1.85	1.9	2.3	1.5	1.8	1.7
6	1.8	1.8	1.8	1.95	2.1	1.9	1.8	1.85	3.1	1.5	1.8	1.7
7	1.8	1.8	1.8	1.9	2.1	1.9	1.9	1.8	2.9	1.65	1.8	1.7
8	1.8	1.75	1.95	1.9	2.2	1.9	2.2	1.8	2.35	1.8	1.8	1.7
9	1.8	1.7	1.9	1.95	2.2	1.9	1.9	1.8	2.5	2.05	1.8	1.8
10	1.8	1.7	1.9	1.9	2.2	1.9	1.8	1.85	2.45	1.8	1.8	1.8
11	1.8	1.7	1.9	2.0	2.2	1.9	1.8	2.0	2.35	1.85	1.8	1.8
12	1.8	1.7	1.9	2.0	2.15	1.9	1.7	2.2	2.3	1.85	1.8	1.8
13	1.7	1.95	2.0	2.0	2.1	1.9	1.7	2.4	2.25	1.8	1.8	1.8
14	1.7	1.9	2.0	2.0	2.1	1.9	1.9	2.25	2.2	1.85	1.8	1.8
15	1.7	1.8	2.05	2.0	2.1	1.8	1.8	2.25	2.2	1.9	1.8	1.8
16	1.7	1.75	2.05	2.0	2.1	1.8	1.7	2.2	2.2	1.8	1.8	1.8
17	1.7	1.7	1.95	2.1	2.1	1.8	1.9	2.2	2.1	1.8	1.8	1.8
18	1.7	1.7	1.85	2.2	2.1	1.8	1.8	2.2	2.1	1.9	1.8	1.8
19	1.8	1.7	2.0	2.2	2.05	1.8	1.75	2.2	2.1	1.9	1.8	1.7
20	1.8	1.7	1.9	2.2	2.0	1.8	1.7	2.35	1.95	1.9	1.8	1.7
21	1.8	1.7	1.9	2.15	2.1	1.8	1.7	2.25	1.8	1.9	1.8	1.7
22	1.8	1.75	1.9	2.1	2.1	1.8	1.7	2.25	1.9	1.9	1.8	1.7
23	1.8	1.7	1.9	2.15	2.05	1.7	1.7	2.3	1.8	1.9	1.8	1.8
24	1.8	1.7	1.9	2.15	2.0	1.7	2.1	2.2	1.7	1.8	1.8	1.8
25	1.8	1.9	1.9	2.1	2.0	1.7	2.1	2.3	1.7	1.8	1.8	1.8
26	1.8	1.75	1.9	2.1	2.0	1.7	2.1	2.3	1.7	1.7	1.8	1.8
27	1.8	1.7	1.9	2.1	2.0	1.7	2.0	2.3	1.7	1.7	1.8	1.8
28	1.8	1.7	1.9	2.1	2.0	1.7	1.9	2.2	1.7	1.7	1.8	1.7
29	1.8	....	1.9	2.1	2.0	1.7	1.85	2.2	1.7	1.95	1.8	1.7
30	1.8	....	1.9	2.1	2.0	1.7	1.8	2.2	1.6	1.8	1.8	1.7
31	1.8	....	1.9	....	2.0	....	1.8	2.2	....	1.7	....	1.7

Daily discharge, in second-feet, of Gallinas River near Las Vegas, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.0	5.0	3.4	10.5	27	16	2	8	19	0.0	0.3	5.0
2	5.0	5.0	10.5	5.0	27	16	2	7	20	.0	1.0	5.0
3	5.0	5.0	7.8	7.8	27	13	2	10	20	.0	5.0	5.0
4	5.0	5.0	10.5	29	27	13	3	14	37	.0	5.0	5.0
5	5.0	5.0	7.8	24	27	9	8	14	51	.0	5.0	1.8
6	5.0	5.0	5.0	14.8	27	9	6	10	280	.0	5.0	1.8
7	5.0	5.0	5.0	10.5	27	9	12	7	177	1.0	5.0	1.8
8	5.0	3.4	14.8	10.5	39	9	43	7	61	5.0	5.0	1.8
9	5.0	1.8	10.5	14.8	39	9	13	7	89	24.0	5.0	5.0
10	5.0	1.8	10.5	10.5	39	9	5	9	79	5.0	5.0	5.0
11	5.0	1.8	10.5	19	38	9	5	21	62	7.8	5.0	5.0
12	5.0	1.8	10.5	19	33	9	3	45	54	7.8	5.0	5.0
13	1.8	14.8	19	19	27	9	3	78	46	5.0	5.0	5.0
14	1.8	10.5	19	19	27	9	13	50	40	7.8	5.0	5.0
15	1.8	5.0	24	19	26	4	5	50	40	10.5	5.0	5.0
16	1.8	3.4	24	19	26	4	3	43	40	5.0	5.0	5.0
17	1.8	1.8	14.8	29	26	4	14	43	29	5.0	5.0	5.0
18	1.8	1.8	7.8	41	25	4	6	40	29	10.5	5.0	5.0
19	5.0	1.8	19	41	20	4	5	40	29	10.5	5.0	1.8
20	5.0	1.8	10.5	41	15	5	3	62	14.8	10.5	5.0	1.8
21	5.0	1.8	10.5	34	25	5	3	47	5.0	10.5	5.0	1.8
22	5.0	3.4	10.5	28	25	5	3	21	10.5	10.5	5.0	1.8
23	5.0	1.8	10.5	34	20	2	3	52	5.0	10.5	5.0	5.0
24	5.0	1.8	10.5	34	15	2	36	38	1.8	5.0	5.0	5.0
25	5.0	10.5	10.5	28	15	2	36	52	1.8	5.0	5.0	5.0
26	5.0	3.4	10.5	28	15	2	36	50	1.8	1.8	5.0	5.0
27	5.0	1.8	10.5	28	15	2	24	49	1.8	1.8	5.0	5.0
28	5.0	1.8	10.5	28	15	2	16	36	1.8	1.8	5.0	1.8
29	5.0	....	10.5	28	16	2	11	35	1.8	14.8	5.0	1.8
30	5.0	....	10.5	28	16	2	8	35	.3	5.0	5.0	1.8
31	5.0	....	10.5	....	16	....	8	35	....	1.8	....	1.8

NOTE.—From January 1 to April 20 and September 17 to December 31 discharges are based on a well-defined rating curve. April 21 to September 16 discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Gallinas River near Las Vegas, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	5.0	1.8	4.38	269	B.
February	14.8	1.8	4.03	224	B.
March	24	3.4	11.6	713	B.
April	41	5.0	23.4	1,390	B.
May	39	15	24.6	1,510	C.
June	16	2	6.6	393	C.
July	43	2	11.0	676	C.
August	78	7	32.7	2,010	C.
September	280	.3	41.6	2,480	B.
October	24	.0	5.93	365	B.
November	5.0	.3	4.71	280	B.
December	5.0	1.8	3.76	231	C.
The year	280	.0	14.5	10,500	

DEVILS RIVER DRAINAGE BASIN.

DEVILS RIVER AT DEVILS RIVER, TEX.

This station, which was established in April, 1900, by the International Boundary Commission, is opposite the Southern Pacific Railroad station at Devils River.

The river is about 50 miles long, has a perennial flow, and during flood periods is subject to great fluctuations. No good location for a gaging station exists on this stream where it would be accessible from the railroad station. The right bank is the talus of a cliff, the left bank is a bottom heavily timbered. At the site chosen the bed of the stream is nearly all a rock ledge, but seamed and faulted so as to be rough. The current changes in such a way as to give materially different discharges for the same gage height. It is therefore necessary to make frequent measurements to determine closely the daily flow.

The highest water on record occurred April 6, 1900, about two weeks before this gage was established. It reached a height of 25.4 feet on the gage, but this is 8 feet higher than any other known flood. Low water is 2 feet on the gage.

The observations at this station during 1909 have been made under the direction of the United States section of the International Boundary Commission.

Discharge measurements of Devils River at Devils River, Tex., in 1909.

[By E. E. Winter.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 4	327	2.3	467	**June** 12	305	2.15	379
9	331	2.3	489	17	303	2.15	391
14	325	2.3	469	25	305	2.2	387
20	331	2.3	473	29	312	2.2	397
25	332	2.3	437	**July** 6	318	2.3	483
30	323	2.25	401	14	279	2.1	336
Feb. 4	325	2.25	408	23	545	3.0	1,254
9	316	2.25	396	30	427	2.6	671
14	332	2.3	480	**Aug.** 5	388	2.5	634
19	339	2.3	462	14	363	2.4	541
23	329	2.25	427	19	337	2.3	456
27	320	2.25	406	26	333	2.25	433
Mar. 4	325	2.25	417	30	342	2.3	457
9	320	2.25	412	**Sept.** 4	327	2.25	423
14	339	2.3	446	15	378	2.45	569
19	317	2.25	411	23	333	2.3	452
25	317	2.25	407	29	327	2.25	430
30	309	2.2	391	**Oct.** 5	323	2.25	421
Apr. 5	321	2.2	438	13	309	2.2	387
10	308	2.2	401	22	309	2.2	393
15	311	2.2	400	26	310	2.2	391
19	309	2.2	382	30	311	2.2	388
24	311	2.2	385	**Nov.** 5	306	2.2	395
29	317	2.25	418	13	310	2.2	399
May 4	312	2.2	397	22	311	2.2	411
12	297	2.15	380	29	319	2.25	427
20	308	2.2	395	**Dec.** 3	318	2.25	414
25	303	2.2	388	13	310	2.2	411
30	313	2.2	401	23	318	2.25	412
June 4	313	2.2	398	29	310	2.2	389

Daily gage height, in feet, of Devils River at Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.3	2.25	2.3	2.2	2.2	2.2	2.2	2.55	2.25	2.25	2.2	2.25
2	2.3	2.25	2.3	2.2	2.2	2.2	2.2	2.5	2.25	2.25	2.2	2.25
3	2.3	2.25	2.3	2.2	2.2	2.2	2.2	2.5	2.25	2.25	2.2	2.25
4	2.3	2.25	2.25	2.2	2.2	2.2	2.2	2.5	2.25	2.25	2.2	2.25
5	2.3	2.25	2.25	2.2	2.2	2.2	2.2	2.5	2.2	2.25	2.2	2.25
6	2.3	2.25	2.25	2.2	2.2	2.2	2.25	2.5	2.2	2.25	2.2	2.2
7	2.3	2.25	2.25	2.2	2.2	2.15	2.25	2.5	2.2	2.25	2.2	2.2
8	2.3	2.25	2.25	2.2	2.2	2.15	2.25	2.5	2.2	2.25	2.2	2.2
9	2.3	2.25	2.25	2.2	2.2	2.15	2.2	2.5	2.2	2.25	2.2	2.2
10	2.3	2.3	2.25	2.2	2.15	2.15	2.2	2.45	2.2	2.2	2.2	2.2
11	2.3	2.3	2.25	2.2	2.15	2.15	2.2	2.45	2.2	2.2	2.2	2.2
12	2.3	2.3	2.35	2.2	2.15	2.15	2.15	2.45	2.2	2.2	2.2	2.2
13	2.3	2.3	2.3	2.2	2.15	2.2	2.15	2.45	2.2	2.2	2.2	2.2
14	2.3	2.3	2.3	2.2	2.15	2.2	2.1	2.4	3.35	2.2	2.2	2.2
15	2.3	2.25	2.25	2.2	2.15	2.15	2.1	2.4	2.5	2.2	2.2	2.2
16	2.3	2.25	2.25	2.2	2.15	2.15	2.1	2.4	2.3	2.2	2.2	2.2
17	2.3	2.3	2.25	2.2	2.2	2.15	2.1	2.35	2.3	2.2	2.2	2.2
18	2.3	2.3	2.25	2.2	2.2	2.15	2.1	2.3	2.3	2.2	2.2	2.2
19	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
20	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
21	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
22	2.3	2.3	2.25	2.2	2.2	2.15	2.15	2.3	2.3	2.2	2.2	2.2
23	2.3	2.25	2.25	2.2	2.2	2.3	3.05	2.3	2.3	2.2	2.2	2.25
24	2.3	2.25	2.25	2.2	2.2	2.2	4.6	2.25	2.3	2.2	2.2	2.25
25	2.3	2.25	2.25	2.2	2.2	2.2	3.1	2.25	2.3	2.2	2.2	2.25
26	2.3	2.25	2.25	2.6	2.2	2.2	2.75	2.25	2.3	2.2	2.2	2.25
27	2.3	2.25	2.25	2.6	2.2	2.2	2.6	2.25	2.3	2.2	2.2	2.2
28	2.3	2.3	2.25	2.3	2.2	2.2	2.6	2.25	2.25	2.2	2.2	2.2
29	2.25	....	2.25	2.25	2.2	2.2	2.6	2.3	2.25	2.2	2.25	2.2
30	2.25	....	2.2	2.25	2.2	2.2	2.6	2.3	2.25	2.2	2.25	2.2
31	2.25	....	2.2	....	2.2	....	2.6	2.25	....	2.2	....	2.2

Daily discharge, in second-feet, of Devils River at Devils River, Tex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	475	400	440	400	395	400	405	650	430	430	390	420
2	470	405	440	410	395	400	415	635	430	425	390	415
3	470	405	440	420	395	400	420	635	425	425	390	a 415
4	a 465	a 405	a 415	430	a 395	a 400	430	635	a 425	420	395	415
5	470	405	415	a 440	395	400	435	a 635	410	a 420	a 395	415
6	475	405	415	430	395	400	a 460	630	410	420	395	410
7	480	400	415	420	395	380	455	620	405	420	395	410
8	485	400	410	410	395	380	445	615	405	415	395	410
9	a 490	a 395	a 410	405	395	380	420	610	400	415	395	410
10	485	440	410	a 400	380	380	410	585	400	390	400	410
11	480	450	410	400	380	380	405	580	400	390	400	410
12	475	460	475	400	a 380	a 380	375	570	400	390	400	410
13	470	470	445	400	380	400	365	565	400	a 385	a 400	a 410
14	a 470	a 480	a 445	400	380	405	a 335	a 540	1,560	385	400	410
15	470	430	440	a 400	380	385	335	530	a 625	390	400	410
16	470	430	430	395	380	385	340	525	480	390	405	410
17	470	460	425	390	395	a 390	340	495	475	390	405	410
18	470	460	420	385	395	390	340	465	470	390	405	405
19	475	a 460	a 410	a 380	395	385	360	a 455	465	390	405	405
20	a 475	460	410	380	a 395	380	360	455	460	390	410	405
21	470	455	410	385	395	380	360	455	455	395	410	400
22	460	450	410	385	390	375	360	455	455	a 395	a 410	400
23	455	a 425	410	385	390	435	a 1,330	455	a 450	395	410	a 410
24	445	420	405	a 385	390	390	3,590	435	450	390	410	401
25	a 435	415	a 405	385	a 390	a 385	1,400	435	450	390	410	410
26	435	410	410	650	390	390	890	a 435	450	a 390	410	410
27	430	a 405	415	650	395	390	670	435	450	390	410	390
28	430	440	420	450	395	395	670	435	430	390	410	390
29	400	....	420	a 420	400	a 395	670	455	a 430	390	a 425	a 390
30	a 400	....	a 390	420	a 400	400	a 670	a 455	430	a 390	425	390
31	400	....	390	....	400	....	670	435	....	390	....	395

a Date of measurement.

Monthly discharge of Devils River at Devils River, Tex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	490	400	460	28,264
February	480	395	430	23,881
March	475	390	420	25,795
April	650	380	420	25,012
May	400	380	391	24,059
June	435	375	391	23,276
July	3,590	335	617	37,944
August	650	435	526	32,360
September	1,560	400	478	28,413
October	430	385	399	24,545
November	425	390	403	24,000
December	420	390	407	25,012
The year	3,590	335	445	322,561

RIO SALADO DRAINAGE BASIN.

RIO SALADO NEAR GUERRERO, TAMAULIPAS, MEXICO.

The Salado is a torrential stream, entering the Rio Grande from the Mexican side about 60 miles below Laredo, or 730 miles by river below El Paso. The town of Guerrero is located on the Salado some 4 miles above its mouth, and the gaging station is 2 miles above the town. The gaging station was established in 1900 by the International Boundary Commission.

The river is a series of pools and rapids. The best pool available was chosen for the station. The banks are sandy clay, not subject to erosion. The bottom is mud. In low water the river is measured by wading among the rocks below the station. Frequent discharge measurements are made to determine closely the daily flow. The highest recorded flood, on June 16, 1903, gave 17.7 on the gage.

The observations at this station have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights for the years 1900 to 1904, which had not hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio Salado near Guerrero, Tamaulipas, Mexico, in 1909.

[By Lassaulx and Garcia.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 3	950	2.5	119	July 3	4,540	16.0	21,399
7 [a]	137	2.3	130	5	5,152	19.0	29,565
11	136	2.2	117	7	3,976	14.0	16,928
15	137	2.1	115	11	3,196	6.5	3,736
19	136	2.1	112	15	2,929	5.0	3,132
23	137	2.1	116	19	2,738	4.2	1,364
27	134	2.0	102	20	2,926	6.0	3,178
30	133	2.0	96	23	2,734	4.4	1,411
Feb. 3	128	1.9	81	28	2,420	3.3	663
7	130	1.9	79	Aug. 3	2,346	2.9	448
11	127	1.8	74	7	2,387	3.2	570
15	126	1.7	70	11	2,353	3.5	609
19	124	1.6	64	13	2,886	6.1	3,339
23	122	1.5	60	15	2,505	4.0	1,120
27	119	1.4	59	19	2,377	3.4	652
Mar. 3	118	1.3	51	23	2,275	2.9	438
7	115	1.2	46	28	3,504	9.2	8,504
11	113	1.1	42	29	4,770	15.2	20,985
15	21	1.0	14	30	5,058	17.2	26,706
20	21	1.0	15	Sept. 3	3,960	11.5	12,465
24	21	1.0	15	7	3,230	7.0	4,067
28	21	.9	14	11	3,029	5.4	1,769
Apr. 1	131	1.9	92	15	2,959	5.1	1,621
3	125	1.8	81	19	2,932	5.0	1,538
7	116	1.2	43	23	2,847	4.6	1,348
8	1,580	4.5	1,138	28	2,789	4.3	1,256
11	142	2.4	137	Oct. 3	2,727	4.0	1,171
15	98	1.3	48	7	2,686	3.8	941
19	66	.9	40	11	2,645	3.6	825
23	63	.8	34	15	2,621	3.5	801
28	62	7	29	19	2,623	3.5	801
May 3	33	.5	23	23	2,600	3.4	777
7	25	.3	15	28	2,561	3.2	747
11	23	.1	12	Nov. 3	2,561	3.2	744
15	21	.0	10	7	2,543	3.1	723
19	20	−.1	8	11	2,540	3.1	727
23	20	−.1	8	15	2,522	3.0	673
27	2,476	7.5	7,024	19	2,524	3.0	679
28	2,522	8.7	8,551	23	2,520	3.0	672
June 3	1,056	3.0	185	27	2,495	2.9	610
7	157	2.3	140	Dec. 3	2,520	3.0	667
11	119	1.8	103	7	2,519	3.0	675
15	117	1.7	86	11	2,496	2.9	601
19	119	1.7	90	15	2,493	2.9	595
23	160	2.4	155	19	2,495	2.9	593
28	116	1.4	73	23	2,515	3.0	643
July 2	3,137	10.6	13,622	28	2,514	3.0	643

[a] Rejected; too large.

Daily gage height, in feet, of Rio Salado near Guerrero, Tamaulipas, Mexico, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.4	1.9	1.3	1.85	0.6	3.7	1.65	3.0	16.45	4.0	3.2	3.0
2	2.45	1.9	1.3	1.65	.5	3.2	12.0	2.9	15.0	4.0	3.2	3.0
3	2.45	1.9	1.3	1.5	.5	2.9	16.75	2.9	10.9	3.9	3.2	3.0
4	2.4	1.9	1.2	1.4	.4	2.5	19.3	3.3	8.9	3.9	3.2	3.0
5	2.4	1.9	1.2	1.35	.4	2.4	18.5	3.3	7.7	3.9	3.2	3.0
6	2.3	1.9	1.2	1.25	.3	2.3	17.3	3.2	7.3	3.8	3.1	3.0
7	2.3	1.9	1.2	1.2	.3	2.25	11.75	3.2	6.95	3.8	3.1	2.9
8	2.3	1.8	1.2	3.85	.2	2.1	7.65	3.1	6.65	3.7	3.1	2.9
9	2.3	1.8	1.1	2.25	.2	2.0	8.25	3.05	6.1	3.7	3.1	2.9
10	2.2	1.8	1.1	2.55	.1	1.9	7.6	3.75	5.8	3.7	3.1	2.9
11	2.2	1.8	1.1	2.3	.1	1.75	6.25	3.65	5.35	3.6	3.1	2.9
12	2.2	1.8	1.1	1.8	.1	1.7	5.7	5.0	5.2	3.6	3.1	2.9
13	2.2	1.8	1.1	1.5	.0	1.6	5.35	5.9	5.1	3.6	3.1	2.9
14	2.1	1.8	1.0	1.4	.0	1.65	5.15	4.45	5.0	3.6	3.1	2.9
15	2.1	1.7	1.0	1.3	.0	1.65	4.95	3.95	5.1	3.5	3.0	2.9
16	2.1	1.7	1.0	1.2	.0	1.45	4.75	3.75	4.95	3.5	3.0	2.9
17	2.1	1.7	1.0	1.1	.0	1.25	4.55	3.5	5.0	3.5	3.0	2.9
18	2.1	1.6	1.0	.95	−.1	1.05	4.35	3.35	5.25	3.5	3.0	2.9
19	2.1	1.6	1.0	.9	−.1	1.7	4.15	3.35	5.3	3.95	3.0	2.9
20	2.1	1.5	1.0	.9	−.1	1.45	6.65	3.2	5.05	4.0	3.0	2.9
21	2.1	1.5	1.0	.9	−.1	1.3	5.4	3.1	4.6	3.75	3.0	2.9
22	2.1	1.5	1.0	.8	−.1	1.6	4.75	3.0	4.6	3.5	3.0	3.0
23	2.1	1.5	1.0	.8	−.1	2.35	4.2	2.9	4.55	3.4	3.0	3.0
24	2.0	1.4	1.0	.8	−.2	2.15	3.85	2.8	4.4	3.4	3.0	3.0
25	2.0	1.4	.9	.8	−.2	1.95	3.65	2.8	4.4	3.3	3.0	3.0
26	2.0	1.4	.9	.7	1.3	1.75	3.5	3.6	4.3	3.3	3.0	3.0
27	2.0	1.4	.9	.7	6.7	1.55	3.4	7.05	4.3	3.2	2.9	3.0
28	2.0	1.3	.9	.7	8.1	1.4	3.3	10.4	4.25	3.2	2.9	3.0
29	2.0	....	.9	.6	6.25	1.4	3.2	15.7	4.2	3.2	2.9	2.9
30	2.0	....	.9	.6	5.35	1.55	3.25	16.75	4.1	3.1	3.0	2.9
31	1.9	....	.9	....	4.2	....	3.05	14.85	....	3.1	....	2.9

RIO SAN JUAN DRAINAGE BASIN.

RIO SAN JUAN NEAR SANTA ROSALIA RANCH, TAMAULIPAS, MEXICO.

The San Juan is a long torrential stream entering the Rio Grande 15 miles below Roma and 790 miles by river below El Paso. Six miles above its mouth is the town of Camargo.

The station was first established in 1900 near La Quemada, 12 miles above Camargo, by the International Boundary Commission, but in time of heavy flood in the Rio Grande backwater reached the station, and on July 14, 1902, it was moved 6 miles farther upstream to its present location near Santa Rosalia ranch, Tamaulipas, Mexico. It is now above backwater.

The river bed at both stations shifts constantly and frequent discharge measurements have been made to determine closely the daily flow. Both banks are of sandy clay which are above high water and do not erode. The bottom of the river is sand which erodes slightly in flood.

Low water (no flow) is approximately zero on the gage. The highest recorded flood, on September 16, 1904, reached 27 feet on the gage.

The observations at both stations have been made under the direction of the Mexican section of the International Boundary Commission.

Discharge measurements and gage heights, 1900 to 1904, which had hitherto been published by the United States Geological Survey, are given in Water-Supply Paper 248.

Discharge measurements of Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico, in 1909.

[By S. Jaso.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*2
Jan. 2	100	1.0	20	June 27	71	.5	600
4	243	2.4	234	28	425	3.8	0
8	145	1.6	74	July 1	5,140	26.0	20,817
13	122	1.3	49	3	5,495	28.0	25,415
18	114	1.2	30	7	3,233	16.3	11,121
24	109	1.1	25	Aug. 10	620	1.2	264
28	98	1.0	22	11	4,315	22.0	17,476
Feb. 3	104	1.0	22	12	5,478	28.0	29,552
8	86	0.9	18	13	3,120	16.0	9,199
12	86	.9	7	17	1,519	5.5	3,930
17	81	.8	4	23	1,149	3.4	1,166
24	73	.75	2	28	6,600	32.5	42,768
27	77	.7	3	29	10,884	53.5	88,160
Mar. 3	76	.7	3	Sept. 2	3,181	16.3	10,306
9	72	.6	3	4	3,210	16.2	10,400
14	62	.6	2	9	3,180	16.0	10,303
19	56	.5	0	13	2,283	6.5	6,158
24	58	.4	0	16	4,793	13.5	19,412
30	45	.2	0	19	2,589	7.3	4,194
Apr. 4	35	.1	0	24	3,106	8.9	8,378
10	658	5.3	1,435	28	1,419	4.4	1,529
12	224	2.15	178	Oct. 4	1,866	3.0	1,806
16	122	1.2	41	10	1,743	1.9	1,437
21	88	.9	8	14	1,666	1.4	1,302
25	79	.7	3	25	1,719	.5	1,105
28	81	.6	3	28	1,255	.3	810
May 4	69	.5	0	Nov. 5	1,976	.55	1,327
9	61	.3	0	9	1,917	.2	1,248
14	51	.2	0	14	1,826	− .3	997
19	41	.1	0	18	1,717	− .9	802
23	71	.8	2	21	1,723	−1.0	752
27	130	1.2	48	24	1,683	−1.4	697
28	642	4.9	1,466	28	1,642	−1.7	575
June 2	216	2.0	126	Dec. 3	1,642	−1.5	881
3	524	4.2	855	8	1,606	−1.8	636
5	207	1.8	99	11	1,619	−1.7	716
10	128	1.0	27	16	1,593	−1.9	581
15	103	.8	5	22	1,613	−1.7	649
20	93	.7	3	25	1,614	−1.7	688
25	83	.5	0	28	1,590	−1.9	670

NOTE.—A new gage installed October 1, 1909. Readings are not comparable with old gage.

Daily gage height, in feet, of Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.0	0.7	......	......	1.5	19.9	1.35	23.25	3.75	0.1	−2.0
2	1.0	1.0	.7	......	......	3.2	24.5	1.25	18.4	3.5	.0	−1.5
3	1.0	1.0	.7	......	......	3.9	26.0	1.2	16.3	3.25	.0	−1.5
4	2.4	1.0	.7	......	......	2.1	21.0	1.35	16.2	2.95	.65	−1.5
5	2.1	.9	.7	......	......	1.75	12.0	1.2	16.2	2.75	.5	−1.6
6	1.85	.9	.7	......	......	1.55	13.15	1.15	16.1	2.55	.15	−1.7
7	1.75	.9	.7	......	......	1.35	14.75	1.7	16.1	2.35	.0	−1.8
8	1.6	.9	.7	......	......	1.3	15.65	1.6	16.0	2.2	.0	−1.75
9	1.5	.9	.6	......	......	1.15	10.85	1.35	15.65	2.05	.5	−1.8
10	1.45	.9	.6	5.05	......	1.0	4.5	1.15	13.35	1.85	.2	−1.7

Daily gage height, in feet, of Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico, for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	1.4	.9	.6	2.9	....	.9	3.85	25.0	6.95	1.65	.05	-1.7
12	1.35	.9	.6	2.0	....	.9	2.85	28.25	6.75	1.55	- .05	-1.6
13	1.3	.9	.6	1.6	....	.9	2.7	20.0	6.5	1.5	- .15	-1.8
14	1.3	.9	.6	1.5	....	.8	2.35	8.5	6.25	1.4	- .3	-1.9
15	1.3	.9	....	1.35	....	.8	2.2	7.0	6.7	1.4	- .45	-1.9
16	1.2	.9	....	1.2	....	.8	2.0	6.0	13.5	1.25	- .65	-1.9
17	1.2	.8	....	1.1	....	.7	1.9	5.5	10.3	1.1	- .8	-1.9
18	1.2	.8	....	1.1	....	.7	1.8	4.5	8.5	1.0	- .95	-1.9
19	1.2	.8	....	1.0	....	.7	1.7	3.95	6.2	0.95	-1.0	-1.9
20	1.2	.8	....	1.0	....	.7	1.7	3.7	6.75	.9	-1.0	-1.9
21	1.2	.8	....	.95	....	.6	5.25	3.55	6.4	.8	-1.0	-1.8
22	1.2	.8	....	.9	....	.6	3.65	3.45	6.1	.7	-1.1	-1.7
23	1.2	.8	....	.8	....	.6	3.15	4.95	5.85	.7	-1.25	-1.65
24	1.15	.8	....	.8	....	.5	2.7	6.5	8.1	.55	-1.4	-1.65
25	1.05	.7	....	.7	1.25	.5	2.3	6.8	6.2	.45	-1.45	-1.7
26	1.0	.7	....	.7	1.25	.5	1.85	7.0	5.3	.4	-1.5	-1.7
27	1.0	.7	....	.7	6.25	.5	1.75	12.6	4.9	.4	-1.6	-1.8
28	1.0	.7	....	.6	5.7	3.4	1.65	28.75	4.45	.3	-1.7	-1.9
29	1.0	....	....	.6	4.3	2.15	1.5	51.75	4.15	.2	-1.85	-1.9
30	1.0	....	....	.6	2.55	1.7	1.5	60.0	3.9	.1	-2.0	-2.0
31	1.0	....	....	....	1.95	....	1.4	43.5	....	.1	....	-2.0

NOTE.—No flow March 15 to April 9, and May 1-24, 1909.

MISCELLANEOUS MEASUREMENTS IN RIO GRANDE DRAINAGE BASIN.

The following miscellaneous discharge measurements were made in the Rio Grande drainage basin in 1909:

Miscellaneous discharge measurements in Rio Grande basin in 1909.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
May 18	Goose Creek	Rio Grande	Wagon Wheel Gap, Colo.	....	[1] 30
May 17	South Fork of Rio Grande.	do	South Fork, Colo	3.34	932
June 21	do	do	do	3.77	1,140
Aug. 4	do	do	do	1.67	142
Oct. 1	do	do	do	1.52	111
May 17	Willow Creek	do	1 mile below South Fork, Colo.	....	[a] 50
Do	Shaw Creek	do	4 miles below South Fork, Colo.	....	[a] 15
Do	Los Pinos Creek	do	2 miles above Del Norte, Colo.	....	[a] 60
May 15	San Antonio Creek	Conejos River	1 mile south of Antonito, Colo.	[b] 11.0	814
June 22	do	do	do	[b] 12.45	....
June 23	do	do	do	[b] 12.55	234
Oct. 1	do	do	do	....	[c] 20
Sept. 30	Chama River	Rio Grande	Chamita, N. Mex	....	[a] 20
Oct. 1	do	do	do	....	[a] 30
June 2	Rio Puerco	do	Rio Puerco, N. Mex	....	[a] .8

[a] Estimated.
[b] Distance from reference point to water surface.
[c] Float measurement.

INDEX.

A. Page.

- Accuracy, degree of ... 24-25
- Acknowledgments to those aiding ... 26
- Acre-foot, definition of ... 12
- Albuquerque district, irrigation in ... 31
- Antonito, Colo.,
  - San Antonio Creek near:
    - discharge ... 101
- Appropriations, amount of ... 5
- Authority for investigations ... 5

B.

- Bluewater Creek, N. Mex., flood on ... 73-75
- Bluewater dam, N. Mex., daily precipitation in vicinity of ... 75
  - failure of ... 73-75
- Bolster, R. H., work of ... 27
- Brownsville, Tex.,
  - Rio Grande near:
    - description ... 65
    - discharge ... 66
    - gage heights ... 67
- Buckman, N. Mex.,
  - Rio Grande near:
    - description ... 41
    - discharge ... 41
    - discharge, daily ... 42
    - discharge, monthly ... 43
    - gage heights ... 42

C.

- Cameron Creek at—
  - Fort Bayard, N. Mex.:
    - description ... 78-79
    - discharge ... 79
    - discharge, monthly ... 79
    - gage heights ... 79
- Cameron Creek basin, stream flow in ... 78-81
- Chama River at—
  - Chamita, N. Mex.:
    - discharge ... 101
- Chamita, N. Mex.,
  - Chama River at:
    - discharge ... 101
- Conejos River basin, stream flow in ... 67-69
- Conejos River near—
  - Mogote, Colo.:
    - description ... 67-68
    - discharge ... 68
    - discharge, daily ... 69
    - discharge, monthly ... 69
    - gage heights ... 68
    - view of ... 34
- Cooperation, credit for ... 26

Page.

- Cooperative data, use of ... 25-26
- Creede, Colo.,
  - Rio Grande near:
    - description ... 34
    - discharge ... 34
    - discharge, daily ... 35
    - discharge, monthly ... 36
    - gage heights ... 35
    - view of ... 34
    - *See also* Thirtymile Bridge.
- Current meter, description of ... 17-18
  - use of ... 18-19
  - views of ... 18
- Current-meter stations, views of ... 16

D.

- Data, accuracy of ... 24-25
  - use of ... 25
- Dayton, N. Mex.,
  - Pecos River near:
    - description ... 86
    - discharge ... 87
    - discharge, daily ... 87-88
    - discharge, monthly ... 88
    - gage heights ... 87
- Definitions of terms ... 11-12
- Del Norte, Colo.,
  - Los Pinos Creek above:
    - discharge ... 101
  - Rio Grande near:
    - description ... 36-37
    - discharge ... 37
    - discharge, daily ... 38
    - discharge, monthly ... 38
    - gage heights ... 37
- Devils River, Tex.,
  - Devils River at:
    - description ... 95
    - discharge ... 96
    - discharge, daily ... 97
    - discharge, monthly ... 97
    - gage heights ... 96
  - Rio Grande below:
    - description ... 56
    - discharge ... 57
    - discharge, daily ... 58
    - discharge, monthly ... 59
    - gage heights ... 57
- Devils River at—
  - Devils River, Tex.:
    - description ... 95
    - discharge ... 96
    - discharge, daily ... 97

Page.
Devils River at—Continued.
  Devils River, Tex.—Continued.
    discharge, monthly.................. 97
    gage heights.................. 96
Devils River drainage basin, stream flow in . 95–97
Discharge, computation of.................. 20–23
  curves for.................. 20
  measurement of.................. 14–19
Discharge measurements, nature of.................. 13
Domestic water supply, importance of.................. 7
Drainage, stream flow and.................. 7–8
Drainage basins, list of.................. 8

E.

Eagle Pass., Tex.,
  Rio Grande at:
    description 59
    discharge.................. 59–60
    discharge, daily.................. 61
    discharge, monthly.................. 61
    gage heights.................. 60
El Paso, Tex.,
  Rio Grande near:
    description.................. 45
    discharge.................. 46
    discharge, daily.................. 47
    discharge, monthly.................. 48
    gage heights.................. 47
Equivalents, list of.................. 12–13
Espanola Valley, irrigation in.................. 31

F.

Faywood, N. Mex.,
  Mimbres River near:
    automatic gage on, view of.................. 76
    description 75–76
    discharge.................. 76
    discharge, daily.................. 77
    discharge, monthly.................. 78
    gage heights.................. 76
Field methods, features of.................. 14–19
Float method, description of.................. 17
Floods, prevention of.................. 8
Follett, W. W., work of.................. 27
Fort Bayard, N. Mex.,
  Cameron Creek at:
    description.................. 78–79
    discharge.................. 79
    discharge, monthly.................. 79
    gage heights.................. 79
  Stephens Creek near:
    description.................. 80
    discharge.................. 80
    gage heights.................. 80
Fort Sumner, N. Mex.—
  Pecos River near:
    description.................. 83–84
    discharge.................. 84
    discharge, daily.................. 85
    discharge, monthly.................. 86
    gage heights.................. 84
Freeman, W. B., work of.................. 26, 27

G.

Gage heights, readings of.................. 13
Gaging stations, classification of.................. 20–23
  list of, in western Gulf of Mexico drainage basins.................. 27–28
Gaging stations, types of, description of..... 16
  views of.................. 16
Gallinas River near—
  Las Vegas, N. Mex.:
    description.................. 93
    discharge.................. 93
    discharge, daily.................. 94
    discharge, monthly.................. 95
    gage heights.................. 94
Goose Creek at—
  Wagon Wheel Gap, Colo.:
    discharge.................. 101
Guerrero, Mexico,
  Rio Salada near:
    description.................. 97–98
    discharge.................. 98
    gage heights.................. 99
Gulf of Mexico (western) drainage basins, gaging stations in.................. 27–28

I.

Ice, measurements under.................. 19, 23
Investigations, authority for.................. 5
  purposes of.................. 7–8
  scope of.................. 6
Irrigation, dependence of, on stream flow..... 7

K.

King, L. T., work of.................. 27

L.

Lakewood, N. Mex.,
  Pecos River near:
    description.................. 88–89
    discharge.................. 89
    discharge, daily.................. 90
    discharge, monthly.................. 90
    gage heights.................. 89
Langtry, Tex.,
  Rio Grande near:
    description.................. 54
    discharge.................. 54–55
    discharge, daily.................. 56
    discharge, monthly.................. 56
    gage heights.................. 55
Laredo, Tex.,
  Rio Grande near:
    description.................. 61–62
    discharge.................. 62
    gage heights.................. 63
Las Vegas, N. Mex.,
  Gallinas River near:
    description.................. 93
    discharge.................. 93
    discharge, daily.................. 94
    discharge, monthly.................. 95
    gage heights.................. 94
Leasburg dam, view of.................. 30
Lobatos, Colo.,
  Rio Grande near:
    description.................. 38–39
    discharge.................. 39
    discharge, daily.................. 40
    discharge, monthly.................. 41
    gage heights.................. 39–40
Los Pinos Creek above—
  Del Norte, Colo.:
    discharge.................. 101

M. Page.

- McChristie, M. E., work of........ 27
- Mathers, J. G., work of........ 27
- Mesilla Valley, irrigation in........ 31
- Miller, C. D., work of........ 27
- Mimbres River basin, stream flow in........ 75-78
- Mimbres River near—
  - Faywood, N. Mex.:
    - automatic gage on, view of........ 76
    - description........ 75-76
    - discharge........ 76
    - discharge, daily........ 77
    - discharge, monthly........ 78
    - gage heights........ 76
- Miner's inch, definition of........ 11
- Miscellaneous measurements in—
  - Rio Grande drainage basin........ 101
- Mogote, Colo.,
  - Conejos River near:
    - description........ 67-68
    - discharge........ 68
    - discharge, daily........ 69
    - discharge, monthly........ 69
    - gage heights........ 68
    - view of........ 34
- Moorhead, Tex.,
  - Pecos River near:
    - description........ 90-91
    - discharge........ 91
    - discharge, daily........ 92
    - discharge, monthly........ 93
    - gage heights........ 92

N.

- Navigation, dependence of, on stream flow... 7

O.

- Office methods, features of........ 20-23

P.

- Padgett, work of........ 27
- Pecos River, concrete flume across, view of.. 30
- Pecos River drainage basin, description of... 81-83
  - stream flow in........ 83-95
- Pecos River near—
  - Dayton, N. Mex.:
    - description........ 86
    - discharge........ 87
    - discharge, daily........ 87-88
    - discharge, monthly........ 88
    - gage heights........ 87
  - Fort Sumner, N. Mex.:
    - description........ 83-84
    - discharge........ 84
    - discharge, daily........ 85
    - discharge, monthly........ 86
    - gage heights........ 84
  - Lakewood, N. Mex.:
    - description........ 88-89
    - discharge........ 89
    - discharge, daily........ 90
    - discharge, monthly........ 90
    - gage heights........ 89
  - Moorhead, Tex.:
    - description........ 90-91
    - discharge........ 91
    - discharge, daily........ 92

Pecos River near—Continued. Page.

- Morehead, Tex.—Continued.
  - discharge, monthly........ 93
  - gage heights........ 92
- Pecos River valley, view of........ 76
- Presidio, Tex.,
  - Rio Grande above:
    - description........ 48
    - discharge........ 49
    - discharge, daily........ 50
    - discharge, monthly........ 51
    - gage heights........ 50
  - Rio Grande below:
    - description........ 51
    - discharge........ 52
    - discharge, daily........ 53
    - discharge, monthly........ 54
    - gage heights........ 53
- Price meters, views of........ 18
- Publications, lists of........ 9-11

R.

- Rating curves, construction and use of........ 20
- Rating tables, construction of........ 20
  - nature of........ 14
- Revision, need for........ 25-26
- Rice, R. C., work of........ 27
- Rio Grande at or near—
  - Buckman, N. Mex.:
    - description........ 41
    - discharge........ 41
    - discharge, daily........ 42
    - discharge, monthly........ 43
    - gage heights........ 42
  - Brownsville, Tex.:
    - description........ 65
    - discharge........ 66
    - gage heights........ 67
  - Creede, Colo.:
    - description........ 34
    - discharge........ 34
    - discharge, daily........ 35
    - discharge, monthly........ 36
    - gage heights........ 35
    - view of........ 34
    - *See also* Thirtymile Bridge.
  - Del Norte, Colo.:
    - description........ 36-37
    - discharge........ 37
    - discharge, daily........ 38
    - discharge, monthly........ 38
    - gage heights........ 37
  - (below) Devils River, Tex.:
    - description........ 56
    - discharge........ 57
    - discharge, daily........ 58
    - discharge, monthly........ 59
    - gage heights........ 57
  - Eagle Pass, Tex.:
    - description........ 59
    - discharge........ 59-60
    - discharge, daily........ 61
    - discharge, monthly........ 61
    - gage heights........ 60
  - El Paso, Tex.:
    - description........ 45
    - discharge........ 46
    - discharge, daily........ 47

Page.
Rio Grande at or near—Continued.
  El Paso, Tex.—Continued.
    discharge, monthly 48
    gage heights 47
  Langtry, Tex.:
    description 54
    discharge 54-55
    discharge, daily 56
    discharge, monthly 56
    gage heights 55
  Laredo, Tex.:
    description 61-62
    discharge 62
    gage heights 63
  Lobatos, Colo.:
    description 38
    discharge 39
    discharge, daily 40
    discharge, monthly 41
    gage heights 39-40
  (above) Presidio, Tex.:
    description 48
    discharge 49
    discharge, daily 50
    discharge, monthly 51
    gage heights 50
  (below) Presidio, Tex.:
    description 51
    discharge 52
    discharge, daily 53
    discharge, monthly 54
    gage heights 53
  Roma, Tex.:
    description 63
    discharge 64
    gage heights 65
  San Marcial, N. Mex.:
    description 43
    discharge 43-44
    discharge, daily 45
    discharge, monthly 45
    gage heights 44
  Thirtymile Bridge (near Creede), Colo.:
    description 32
    discharge 33
    discharge, daily 33
    discharge, monthly 34
    gage heights 33
Rio Grande canal, headgates of, view of 30
  largest concrete drop in, view of 30
Rio Grande drainage basin, description of 28-32
  gaging stations in 27-28
  stream flow in 28-101
  irrigation in 31
  miscellaneous measurements in 101
Rio Grande (South Fork) at—
  South Fork, Colo.:
    discharge 101
    gage heights 101
Rio Puerco at—
  Rio Puerco, N. Mex.:
    discharge 101
Rio Salado drainage basin, stream flow in 97-99
Rio Salada near—
  Guerrero, Mexico:
    description 97-98
    discharge 98
    gage heights 99

Page.
Rio San Juan drainage basin, stream flow in 99-101
Rio San Juan near—
  Santa Rosalia ranch, Tamaulipas, Mex.:
    description 99-100
    discharge 100
    gage heights 100-101
Roma, Tex.,
  Rio Grande near:
    description 63
    discharge 64
    gage heights 65
Run-off, computation of 20-23
  definition of 11
Russell, G. H., work of 27

S.

San Antonio Creek near—
  Antonito, Colo.:
    discharge 101
San Luis Valley, irrigation in 31
San Marcial, N. Mex.,
  Rio Grande near:
    description 43
    discharge 43-44
    discharge, daily 45
    discharge, monthly 45
    gage heights 44
Santa Fe Creek at—
  Santa Fe, N. Mex.:
    description 69-70
    discharge 70
    discharge, daily 71-72
    discharge, monthly 73
    gage heights 70
Santa Fe Creek basin, stream flow in 69-73
Santa Rosalia ranch, Tamaulipas, Mex.,
  Rio San Juan near:
    description 99-100
    discharge 100
    gage heights 100-101
Second-foot, definition of 11
Section, changes in, estimating for 21-23
Shaw Creek below—
  South Fork, Colo.:
    discharge 101
Slope method, description of 15
South Fork, Colo.,
  Rio Grande (South Fork) at:
    discharge 101
  Shaw Creek below:
    discharge 101
  Willow Creek below:
    discharge 101
Stephens Creek near—
  Fort Bayard, N. Mex.:
    description 80
    discharge 80
    gage heights 80
Stevens, G. C., work of 27
Stewart, J. B., work of 27
Stream measurement, accuracy of 24-25
  data on, use of 25
  methods of 14-19
Sullivan, V. L., work of 27
Sutton, W. H., work of 27
Swamps, dependence of drainage of, on stream flow 7-8

T. Page.

Tables, explanation of 13-14
Taos district (valleys of the), irrigation in 31
Terms, definitions of 11-12
Thirtymile Bridge (near Creede), Colo.,
  Rio Grande at:
    description 32
    discharge 33
    discharge, daily 33
    discharge, monthly 34
    gage heights 33

V.

Velocity method, description of 15-16

W. Page.

Wagon Wheel Gap, Colo.,
  Goose Creek at:
    discharge 101
Walters, M. I., work of 27
Water power, dependence of, on stream flow 7
Water supply, dependence of, on stream flow 7
Weir method, description of 15
Willow Creek below—
  South Fork, Colo.:
    discharge 101
Wood, Mrs. B. D., work of 27
Work, division of 26-27

○

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 269

SURFACE WATER SUPPLY OF THE UNITED STATES

1909

PART IX. COLORADO RIVER BASIN

PREPARED UNDER THE DIRECTION OF M. O. LEIGHTON

BY

W. B. FREEMAN AND R. H. BOLSTER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

CONTENTS.

Page.

Introduction 7
  Authority for investigations 7
  Scope of investigations 8
  Purposes of the work 9
  Publications 10
  Definition of terms 13
  Convenient equivalents 14
  Explanation of tables 15
  Field methods of measuring stream flow 16
  Office methods of computing and studying discharge and run-off 22
  Accuracy and reliability of field data and comparative results 26
  Use of the data 28
  Cooperative data 28
  Cooperation and acknowledgements 29
  Division of work 30
Gaging stations in Colorado River basin 30
General features of Colorado River basin 34
Green River and the main Colorado River 35
  Description 35
  Green River at Greenriver, Utah 39
  Colorado River at Yuma, Ariz 44
  Salton Sink 48
    Salton Sea near Salton, Cal 48
    Alamo River near Brawley, Cal 50
    New River near Brawley, Cal 51
Tributary basins 52
  Duchesne River basin 52
    Description 52
    Duchesne River at Myton, Utah 55
    Strawberry River above mouth of Indian Creek, in Strawberry Valley, Utah 58
    Strawberry River below mouth of Indian Creek in Strawberry Valley, Utah 59
    Strawberry River at Theodore, Utah 60
    Indian Creek in Strawberry Valley 62
    Trail Hollow Creek in Strawberry Valley, Utah 64
    Lake Fork below forks near Whiterocks, Utah 65
    Lake Fork near Myton, Utah 67
    Uinta River near Whiterocks, Utah 70
    Uinta River at Fort Duchesne, Utah 72
    Whiterocks River near Whiterocks, Utah 74
  Price River basin 77
    Description 77
    Price River near Helper, Utah 77

Tributary basins—Continued Page.

- San Rafael River basin 79
  - Description 79
  - San Rafael River near Greenriver, Utah 79
  - Cottonwood Creek near Orangeville, Utah 81
  - Ferron Creek near Ferron, Utah 83
  - Huntington Creek near Huntington, Utah 85
- Grand River basin 87
  - Description 87
  - North Fork of Grand River near Grand Lake, Colo 90
  - Grand River near Granby, Colo 92
  - Grand River at Sulphur Springs, Colo 94
  - Grand River near Kremmling, Colo 97
  - Grand River at Glenwood Springs, Colo 100
  - Grand River near Palisades, Colo 102
  - North Inlet to Grand Lake at Grand Lake, Colo 105
  - Grand Lake outlet at Grand Lake, Colo 105
  - South Fork of Grand River near Lehman, Colo 107
  - Fraser River basin 110
    - Fraser River at Granby, Colo 110
    - Cooperative data for stations in Fraser River basin 112
      - Description 112
      - Fraser River at upper station near Fraser, Colo 113
      - Fraser River at lower station near Fraser, Colo 115
      - Big (East) Jim Creek at mouth near Fraser, Colo 118
      - Little (West) Jim Creek at mouth near Fraser, Colo 121
      - Vasquez River at upper station near Fraser, Colo 124
      - Vasquez River at lower station near Fraser, Colo 126
      - Elk Creek at mouth near Fraser, Colo 129
      - St. Louis Creek at upper station near Fraser, Colo 132
      - St. Louis Creek at lower station near Fraser, Colo 134
      - North Ranch Creek at upper station near Rollins Pass, Colo. 137
      - North Ranch Creek at lower station near Rollins Pass, Colo. 139
      - Middle Ranch Creek at upper station near Arrow, Colo 142
      - Middle Ranch Creek at lower station near Arrow, Colo 144
      - South Ranch Creek at upper station near Arrow, Colo 147
      - South Ranch Creek at lower station near Arrow, Colo 150
  - Williams Fork basin 153
    - Williams Fork near Sulphur Springs, Colo 153
  - Eagle River basin 155
    - Eagle River at Gypsum, Colo 155
  - Roaring Fork basin 157
    - Description 157
    - Roaring Fork near Emma, Colo 157
    - Roaring Fork at Glenwood Springs, Colo 159
    - Frying Pan River at Basalt, Colo 161
    - Crystal River near Carbondale, Colo 163
  - Divide Creek basin 165
    - Description 165
    - West Divide Creek at Hostutler's ranch, near Raven, Colo 166
    - West Divide Creek at Raven, Colo 166
  - Mamm Creek basin 168
    - West Mamm Creek near Rifle, Colo 168

Tributary basins—Continued.

Grand River basin—Continued.

Page
Gunnison River basin 169
Description 169
Gunnison River at River Portal, Colo 172
Uncompahgre River at Fort Crawford, Colo 174
Uncompahgre River at Montrose, Colo 176
Uncompahgre River near Delta, Colo 178
Fremont River basin 179
Description 179
Fremont River near Thurber, Utah 179
Muddy Creek near Emery, Utah 181
Escalante River basin 183
Escalante Creek near Escalante, Utah 183
San Juan River basin 185
Description 185
Flood in San Juan Valley, September 5 and 6, 1909 187
General features 187
Precipitation 188
San Juan River proper 189
Animas River 190
La Plata River 190
Résumé 190
San Juan River at Blanco, N. Mex 191
Animas River at Aztec, N. Mex 194
La Plata River at La Plata, N. Mex 196
Little Colorado River basin 200
Description 200
Little Colorado River at St. Johns, Ariz 200
Little Colorado River at Woodruff, Ariz 202
Little Colorado River at Holbrook, Ariz 202
Evaporation at Holbrook, Ariz 203
Clear Creek near Winslow, Ariz 205
Flood on Zuni River, Ariz., September 6, 1909 206
Virgin River basin 210
Description 210
Virgin River at Virgin, Utah 210
Santa Clara River near Central, Utah 212
Santa Clara River near St. George, Utah 214
Muddy River near Moapa, Nev 216
Gila River basin 217
Description 217
Gila River near Redrock, N. Mex 219
San Francisco River at Alma, N. Mex 222
Santa Cruz River near Nogales, Ariz 224
Santa Cruz River and ditches at Tucson, Ariz 225
Salt River Basin 227
Description 227
Salt River at McDowell, Ariz 227
Verde River at McDowell, Ariz 230
Miscellaneous measurements in Colorado River drainage basin 232
Index 237

ILLUSTRATIONS.

Page.

PLATE I. Typical gaging stations: *A*, For bridge measurement; *B*, For wading measurement........ 18

II. Small Price current meters........ 20

III. Graphic method of determining daily discharge........ 24

IV. *A*, Dam site for reservoir on Williams Fork, Grand River, Colo.; *B*, Reservoir site in West Fork of Lake Fork above Forks, Utah...... 54

V. *A*, Power plant of Colorado Yule Marble Co., on Crystal River, near Marble, Colo.; *B*, Middle Box Canyon of Gila River, near Redrock, N. Mex........ 164

VI. Map of San Juan River drainage basin, showing rainfall and gaging stations........ 188

VII. Flood on Animas River, Sept. 6, 1909: *A*, View showing overflow of left bank in vicinity of gaging station at Aztec, N. Mex.; *B*, View at footbridge near Durango power plant, Durango, N. Mex... 190

VIII. Zuni dam failure: *A*, Spillway surface, looking downstream, showing depression cavity, wrecked spillway, and both wrecked walls; *B*, Lower toe of dam showing movement and break in masonry at spillway........ 206

IX. Zuni dam failure: *A*, View of spillway, looking northeast; *B*, View of intake, looking northeast........ 208

FIGURE 1. Map of Zuni River drainage basin, showing rainfall stations........ 207

SURFACE WATER SUPPLY OF THE COLORADO RIVER BASIN, 1909.

By W. B. **Freeman** and R. H. **Bolster**.

INTRODUCTION.

AUTHORITY FOR INVESTIGATIONS.

This volume contains results of flow measurements made on certain streams in the United States. The work was performed by the water-resources branch of the United States Geological Survey, either independently or in cooperation with organizations mentioned herein. These investigations are authorized by the organic law of the Geological Survey (Stat. L., vol. 20, p. 394), which provides, among other things, as follows:

> Provided that this officer [the Director] shall have the direction of the Geological Survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

Inasmuch as water is the most abundant and most valuable mineral in nature, the investigation of water resources is included under the above provision for investigating mineral resources. The work has been supported since the fiscal year ending June 30, 1895, by appropriations in successive sundry civil bills passed by Congress under the following item:

> For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

The various appropriations that have been made for this purpose are as follows:

Annual appropriations for the fiscal year ending June 30—

1895	$12,500
1896	20,000
1897 to 1900, inclusive	50,000
1901 to 1902, inclusive	100,000
1903 to 1906, inclusive	200,000
1907	150,000
1908 to 1910, inclusive	100,000
1911	150,000

SCOPE OF INVESTIGATIONS.

These investigations of stream flow are not complete nor do they include all the river systems or parts thereof that might purposefully be studied. The scope of the work is limited by the appropriations available. The field covered is the widest and the character of the work is believed to be the best possible under the controlling conditions. The work would undoubtedly have greater scientific importance and ultimately be of more practical value if the money now expended for wide areas were concentrated on a few small drainage basins; but such a course is impossible because general appropriations made by Congress are applicable to all parts of the country. Each part demands its proportionate share of the benefits.

It is essential that records of stream flow shall be kept during a period of years long enough to determine within reasonable limits the entire range of flow from the absolute maximum to the absolute minimum. The length of such a period manifestly differs for different streams. Experience has shown that the records for some streams should cover from 5 to 10 years, and for other streams 20 years or even more, the limit being determined by the relative importance of the stream and the interdependence of the results with other long-time records on adjacent streams.

In the performance of this work an effort is made to reach the highest degree of precision possible with a rational expenditure of time and a judicious expenditure of a small amount of money. In all engineering work there is a point beyond which refinement is needless and wasteful, and this statement applies with especial force to stream-flow measurements. It is confidently believed that the stream-flow data presented in the publications of the Survey are in general sufficiently accurate for all practical purposes. Many of the records are, however, of insufficient length, owing to the unforeseen reduction of appropriations and consequent abandonment of stations. All persons are cautioned to exercise the greatest care in using such incomplete records.

Records have been obtained at more than 1,550 different points in the United States, and in addition the surface water supply of small areas in Seward Peninsula and the Yukon-Tanana region, Alaska, has been investigated. During 1909 regular gaging stations were maintained by the Survey and cooperating organizations at about 850 points in the United States, and many miscellaneous measurements were made at other points. Data were also obtained in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country and will be made available in the regular surface water-supply papers and in special papers from time to time.

PURPOSES OF THE WORK.

The results contained in this volume are requisite to meet the immediate demands of many public interests, including navigation, irrigation, domestic water supply, water power, swamp and overflow land drainage, and flood prevention.

Navigation.—The Federal Government has expended more than $250,000,000 for the improvement of inland navigation, and prospective expenditures will approximate several times this amount. It is obvious that the determination of stream flow is necessary to the intelligent solution of the many problems involved.

Irrigation.—The United States is now expending $51,000,000 on Federal irrigation systems, and this amount is far exceeded by the private expenditures of this nature in the arid West. The integrity of any irrigation system depends absolutely on the amount of water available. Therefore investigations of stream flow in that portion of the country are not only of first importance in the redemption of the lands, but constitute an insurance of Federal and private investments.

Domestic water supply.—The highest use of water is for domestic supply, and although this branch of the subject is of less direct Federal interest than the branches already named, it nevertheless has so broad a significance with respect to the general welfare that the Federal Government is ultimately and intimately concerned.

Water power.—The development of the water power of the country is an economic necessity. Our stock of coal is being rapidly depleted, and the cost of steam power is increasing accordingly. Industrial growth and, as a consequence, the progress of the United States as a nation will cease if cheap power is not available. Water power affords the only avenue now open. When the electric transmission of power was accomplished, the relation of our water powers to national economy changed entirely. Before the day of electric transmission water power was important only at the locality at which it was generated, but it has now become a public utility in which the individual citizen is vitally interested. Inasmuch as the amount of water power that may be made available depends on the flow of rivers, the investigation of flow becomes a prerequisite in the judicious management of this source of energy.

Drainage of swamp and overflowed lands.—More than 70,000,000 acres of the richest land in this country are now practically worthless or of precarious value by reason of overflow and swamp conditions. When this land is drained, it becomes exceedingly productive, and its value increases many fold. Such reclamation would add to the national assets at least $700,000,000. The study of run-off is the first consideration in connection with drainage projects. If by the drainage of a large area into any particular channel that channel becomes so gorged with water which it had not hitherto been called upon to convey that overflow is caused in places where previously the land was not subject to inundation, then drainage results merely in an exchange of land values. This is not the purpose of drainage improvement.

Flood prevention.—The damage from floods in the United States probably exceeds on the average $100,000,000 annually, and in the year 1908, according to estimates based on reliable data, the aggregate damage approximated $250,000,000. Such an annual tax on the property of great regions should be reduced in the orderly progress of government. It goes without saying that any consideration of flood prevention must be based on a thorough knowledge of stream flow, both in the contributing areas which furnish the water and along the great lowland rivers.

PUBLICATIONS.

The data on stream flow collected by the United States Geological Survey since its inception have appeared in the annual reports, bulletins, and water-supply papers. Owing to natural processes of evolution and to changes in governmental requirements, the character of the work and the territory covered by these different publications has varied greatly. For the purpose of uniformity in the presentation of reports a general plan has been agreed upon by the United States Reclamation Service, the United States Forest Service, the United States Weather Bureau, and the United States Geological Survey, according to which the area of the United States has been divided into 12 parts, whose boundaries coincide with certain natural drainage lines. The areas so described are indicated by the following list of papers on surface water supply for 1909. The dividing line between the North Atlantic and South Atlantic drainage areas lies between York and James rivers.

Papers on surface water supply of the United States, 1909.

Part.	No.	Title.	Part.	No.	Title.
I	261	North Atlantic coast.	VI	266	Missouri River basin.
II	262	South Atlantic coast and eastern Gulf of Mexico.	VII	267	Lower Mississippi River basin.
			VIII	268	Western Gulf of Mexico.
III	263	Ohio River basin.	IX	269	Colorado River basin.
IV	264	St. Lawrence River basin.	X	270	Great Basin.
V	265	Upper Mississippi River and Hudson Bay basin.	XI	271	California.
			XII	272	North Pacific coast.

The following table gives the character of data regarding stream flow at regular stations to be found in the various publications of the United States Geological Survey, exclusive of all special papers.

Numbers of reports are inclusive, and dates also are inclusive, so far as the data are available:

Stream-flow data in reports of the United States Geological Survey.

[Ann.—Annual Report; B.—Bulletin; W. S.—Water-Supply Paper.]

Report.	Character of data.	Year.
10th Ann., pt. 2	Descriptive information only	
11th Ann., pt. 2	Monthly discharge	1884 to Sept., 1890.
12th Ann., pt. 2	do	1884 to June 30, 1891.
13th Ann., pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th Ann., pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1888 to Dec. 31, 1893.
B. 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th Ann., pt. 2	Descriptive information only	
B. 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W. S. 11	Gage heights (also gage heights for earlier years)	1896.
18th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for earlier years.)	1895 and 1896.
W. S. 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W. S. 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W. S. 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W. S. 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th Ann., pt. 4	Monthly discharge (also for many earlier years)	1898.
W. S. 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.
21st Ann., pt. 4	Monthly discharge	1899.
W. S. 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d Ann., pt. 4	Monthly discharge	1900.
W. S. 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W. S. 75	Monthly discharge	1901.
W. S. 82 to 85	Complete data	1902.
W. S. 97 to 100	do	1903.
W. S. 124 to 135	do	1904.
W. S. 165 to 178	do	1905.
W. S. 201 to 214	Complete data, except descriptions	1906.
W. S. 241 to 252	Complete data	1907–8.
W. S. 261 to 272	do	1909.

NOTE.—No data regarding stream flow are given in the 15th and 17th annual reports.

The records at most of the stations discussed in these reports extend over a series of years. An index of the reports containing records prior to 1904 has been published in Water-Supply Paper 119. The first table which follows gives, by years and drainage basins, the numbers of the papers on surface water supply published from 1899 to 1909. Wherever the data for a drainage basin appear in two papers the number of one is placed in parentheses and the portion of the basin covered by that paper is indicated in the second table. For example, in 1904 the data for Missouri River were published in Water-Supply Papers 130 and 131, and the portion of the records contained in Water-Supply Paper 131, as indicated by the second table, is that relating to Platte and Kansas rivers.

Numbers of water-supply papers containing results of stream measurements, 1899–1909.

	1899[a]	1900[b]	1901	1902	1903	1904	1905	1906	1907–8	1909
Atlantic coast and eastern Gulf of Mexico:										
New England rivers..	35	47	65,75	82	97	124	165	201	241	261
Hudson River to Delaware River, inclusive...........	35	47,(48)	65,75	82	97	125	166	202	241	261
Susquehanna River to York River, inclusive.............	35	48	65,75	82	97	126	167	203	241	261
James River to Yadkin River, inclusive...............	(35),36	48	65,75	(82),83	(97),98	126	167	203	242	262
Santee River to Pearl River, inclusive....	36	48	65,75	83	98	127	168	204	242	262
St. Lawrence River......	36	49	65,75	(82),83	97	129	170	206	244	264
Hudson Bay............	....	....	66,75	85	100	130	171	207	245	265
Mississippi River:										
Ohio River..........	36	48,(49)	65,75	83	98	128	169	205	243	263
Upper Mississippi River.............	36	49	65,75	83	98,(99)	128, (130)	171	207	245	265
Missouri River.......	(36),37	49,(50)	66,75	84	99	130, (131)	172	208	246	266
Lower Mississippi River.............	37	50	(65), 65,75	(83),84	(98),99	(128), 131	(169), 173	(205), 209	247	267
Western Gulf of Mexico..	37	50	66,75	84	99	132	174	210	248	268
Pacific coast and Great Basin:										
Colorado River.......	(37),38	50	66,75	85	100	133, (134)	175, (177)	211, (213)	249, (251)	269, (271)
Great Basin..........	38,(39)	51	66,75	85	100	133, (134)	176, (177)	212, (213)	250, (251)	270, (271)
South Pacific coast to Klamath River, inclusive...........	(38),39	51	66,75	85	100	134	177	213	251	271
North Pacific coast...	38	51	66,75	85	100	135	(177), 178	214	252	272

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39.

[b] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52.

Numbers of water-supply papers containing data covering portions of drainage basins.

No.	River basin.	Tributaries included.
35	James...............................	
36	Missouri............................	Gallatin.
37	Colorado............................	Green, Gunnison, Grand above junction with Gunnison.
38	Sacramento..........................	Except Kings and Kern.
39	Great Basin.........................	Mohave.
48	Delaware............................	Wissahickon and Schuylkill.
49	Ohio................................	Scioto.
50	Missouri............................	Loup and Platte near Columbus, Nebr. All tributaries below junction with Platte.
65	Lower Mississippi...................	Yazoo.
82	James............................... St. Lawrence........................	Lake Ontario, tributaries to St. Lawrence River proper.
83	Lower Mississippi...................	Yazoo.
97	James...............................	
98	Lower Mississippi...................	Do.
99	Upper Mississippi...................	Tributaries from the west.
128	Lower Mississippi...................	Yazoo.
130	Upper Mississippi...................	Tributaries from the west.
131	Missouri............................	Platte, Kansas.
134	Colorado............................ Great Basin.........................	Data near Yuma, Ariz., repeated. Susan, Owens, Mohave.
169	Lower Mississippi...................	Yazoo.
177	Colorado............................ Great Basin......................... North Pacific coast.................	Below junction with Gila. Susan repeated, Owens, Mohave. Rogue, Umpqua, Siletz.
205	Lower Mississippi...................	Yazoo, Homochitto.
213	Colorado............................ Great Basin.........................	Data at Hardyville repeated; at Yuma, Salton Sea. Owens, Mohave.
251	Colorado............................	Yuma and Salton Sea stations repeated.
271	Great Basin.........................	Owens River Basin.

The order of treatment of stations in any basin in these papers is downstream. The main stem of any river is determined on the basis of drainage area, local changes in name and lake surface being disregarded. After all stations from the source to the mouth of the main stem of the river have been given, the tributaries are taken up in regular order from source to mouth. The tributaries are treated the same as the main stream, all stations in each tributary basin being given before taking up the next one below.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated above, and in the records for large lakes, where it is often clearer to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups: (1) Those which represent a rate of flow, as second-feet, gallons per minute, miner's inches, and run-off in second-feet per square mile, and (2) those which represent the actual quantity of water, as run-off in depth in inches and acre-feet. They may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second and is the rate of discharge of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed by the use of the factors given in the following table of equivalents.

"Gallons per minute" is generally used in connection with pumping and city water supply.

The "miner's inch" is the rate of discharge of water that passes through an orifice 1 inch square under a head which varies locally. It is commonly used by miners and irrigators throughout the West, and is defined by statute in each State in which it is used.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off in depth in inches on drainage area" is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

"Acre-foot" is equivalent to 43,560 cubic feet, and is the quantity required to cover an acre to the depth of 1 foot. It is commonly used in connection with storage for irrigation work.

CONVENIENT EQUIVALENTS.

The following is a list of convenient equivalents for use in hydraulic computations:

1 second-foot equals 40 California miner's inches (law of March 23, 1901).
1 second-foot equals 38.4 Colorado miner's inches.
1 second-foot equals 40 Arizona miner's inches.
1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,272 gallons for one day.
1 second-foot equals 6.23 British imperial gallons per second.
1 second-foot for one year covers 1 square mile 1.131 feet or 13.572 inches deep.
1 second-foot for one year equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one day covers 1 square mile 0.03719 inch deep.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet.
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 California miner's inches equals 18.7 United States gallons per second.
100 California miner's inches equals 96.0 Colorado miner's inches.
100 California miner's inches for one day equals 4.96 acre-feet.
100 Colorado miner's inches equals 2.60 second-feet.
100 Colorado miner's inches equals 19.5 United States gallons per second.
100 Colorado miner's inches equals 104 California miner's inches.
100 Colorado miner's inches for one day equals 5.17 acre-feet.
100 United States gallons per minute equals 0.223 second-foot.
100 United States gallons per minute for one day equals 0.442 acre-foot.
1,000,000 United States gallons per day equals 1.55 second-feet.
1,000,000 United States gallons equals 3.07 acre-feet.
1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot equals 7.48 gallons.
1 cubic foot of water weighs 62.5 pounds.

1 cubic meter per minute equals 0.5886 second-foot.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
$1\frac{1}{3}$ horsepower equals about 1 kilowatt.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$=net horsepower on water wheel realizing 80 per cent of theoretical power.

EXPLANATION OF TABLES.

For each drainage basin there is given a brief general description covering such features as area, source, tributaries, topography, geology, forestation, rainfall, ice conditions, irrigation, storage, power possibilities, and other special features of importance or interest.

For each regular current-meter gaging station are given in general, and so far as available, the following data: Description of station, list of discharge measurements, table of daily gage heights, table of daily discharges, table of monthly and yearly discharges, and run-off. For stations located at weirs or dams the gage-height table is omitted.

In addition to statements regarding the location and installation of current-meter stations the descriptions give information in regard to any conditions which may affect the constancy of the relation of gage height to discharge, covering such points as ice, logging, shifting conditions of flow, and backwater; also information regarding diversions which decrease the total flow at the measuring section. Statements are also made regarding the accuracy and reliability of the data.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, name of hydrographer, width and area of cross section, gage height, and discharge in second-feet.

The table of daily gage height gives the daily fluctuations of the surface of the river as found from the mean of the gage readings taken each day. At most stations the gage is read in the morning and in the evening. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. All gage heights during ice conditions, backwater from obstructions, etc., are published as recorded, with suitable footnotes. The rating is not applicable for such periods unless the proper correction to the gage heights is known and applied. Attention is called to the fact that the zero of the gage is placed at an arbitrary datum and has no relation to zero flow or the bottom of the river. In general, the zero is located somewhat below the lowest known flow, so that negative readings shall not occur.

The discharge measurements and gage heights are the base data from which rating tables, daily discharge tables, and monthly discharge tables are computed.

The rating table gives, either directly or by interpolation, the discharge in second-feet corresponding to every stage of the river recorded during the period for which it is applicable. It is not published in this report, but can be determined from the gage heights and discharges for the purposes of verifying the published results, as follows:

First plot the discharge measurements for the current and earlier years on cross-section paper with gage heights in feet as ordinates and discharges in second-feet as abscissas. Then tabulate a number of gage heights taken from the daily gage-height table for the complete range of stage given and the corresponding discharges for the days selected from the daily discharge table and plot the values on cross-section paper. The last points plotted will define the rating curve used and will lie among the plotted discharge measurements. After drawing the rating curve, a table can be developed by scaling off the discharge in second-feet for each tenth foot of gage height. These values should be so adjusted that the first differences shall always be increasing or constant, except for known backwater conditions.

The table of daily discharge gives the discharges in second-feet corresponding to the observed gage heights as determined from the rating tables.

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge consequently larger than given in the maximum column. Likewise, in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet for each second during the month. On this the computations for the remaining columns, which are defined on page 13, are based.

FIELD METHODS OF MEASURING STREAM FLOW.

There are three distinct methods of determining the flow of open-channel streams: (1) By measurements of slope and cross section and the use of Chezy's and Kutter's formulas; (2) by means of a weir or dam; (3) by measurements of the velocity of the current and of the area of the cross section. The method chosen depends on the local physical conditions, the degree of accuracy desired, the funds available, and the length of time that the record is to be continued.

Slope method.—Much information has been collected relative to the coefficients to be used in the Chezy formula, $v=c\sqrt{Rs}$. This has been utilized by Kutter, both in developing his formula for c and in determining the values of the coefficient n which appears therein. The results obtained by the slope method are in general only roughly approximate, owing to the difficulty in obtaining accurate data and the uncertainty of the value for n to be used in Kutter's formula. The most common use of this method is in estimating the flood discharge of a stream when the only data available are the cross section, the slope as shown by marks along the bank, and a knowledge of the general conditions. It is seldom used by the United States Geological Survey.[1]

Weir method.—Relatively few stations are maintained at weirs or dams by the United States Geological Survey.. Standard types of sharp-crested and broad-crested weirs within the limits for which accurate coefficients have been experimentally obtained give very accurate records of discharge if properly maintained. At practically all broad-crested weirs, however, there is a diversion of water either through or around the dam, usually for the purpose of development of water power. The flow is often complicated and the records are subject to errors from such sources as leakage through the dam, backwater at high stages, uncertainty regarding coëfficient, irregularity of crest, obstructions from logs or ice, use of flashboards, old turbines with imperfect ratings, and many others depending on the type of development and the uses of the diverted water.

In general records of discharge at dams are usually accurate enough for practical use if no others are available. It has been the general experience of the United States Geological Survey, however, that records at current-meter gaging stations under unobstructed channel conditions are more accurate than those collected at dams, and where the conditions are reasonably favorable are practically as good as those obtained at sharp-crested weirs.[2]

Velocity method.—Streams in general present throughout their courses to a greater or less extent all conditions of permanent, semipermanent, and varying conditions of flow. In accordance with the location of the measuring section with respect to these physical conditions, current-meter gaging stations may in general be divided into four classes—(1) those with permanent conditions of flow;

---

[1] Full information regarding this method is given in the various textbooks on hydraulics.

[2] The determination of discharge over the different types of weirs and dams is treated fully in "Weir experiments, coefficients, and formulas" (Water-Supply Paper 200) and in the various text-books on hydraulics. "Turbine water-wheel tests and power tables" (Water-Supply Paper 180) treats of the dis charge through turbines when used as meters. The edition of the latter water-supply paper is nearly exhausted. It can, however, be consulted at most of the larger libraries of the country or it can be obtained from the superintendent of documents, Washington, D. C., at a cost of 20 cents.

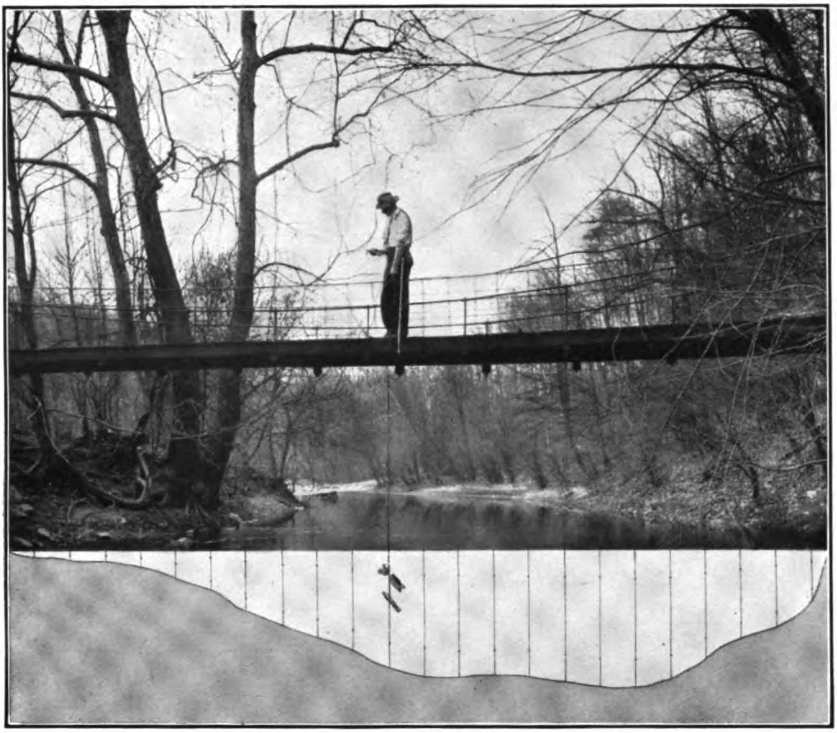
(2) those with beds which change only during extreme high water; (3) those with beds which change frequently, but which do not cause a variation of more than about 5 per cent of the discharge curves from year to year; and (4) those with constantly shifting beds. In determining the daily flow different office methods are necessary for each class. The field data on which the determinations are based and the methods of collecting them are, however, in general the same.

Great care is taken in the selection and equipment of gaging stations for determining discharge by velocity measurements, in order that the data may have the required degree of accuracy. They are located, as far as possible, at such points that the relation between gage height and discharge will always remain constant for any given stage. The experience of engineers of the Geological Survey has been that permanency of conditions of flow is the prime requisite of any current-meter gaging station when maintained for several years unless funds are available to cover all changes in conditions of flow. A straight, smooth section without cross currents, backwater, boils, etc., at any stage is highly desirable, but on most streams is not attainable except at the cost of a cable equipment. Rough, permanent sections, if measurements are properly made by experienced engineers, taking measuring points at a distance apart of 5 per cent or less of the total width, will, within reasonable limits, yield better results for a given outlay of money than semipermanent or shifting sections with smooth, uniform current. So far as possible stations are located where the banks are high and not subject to overflow at high stages and out of the influence of tributary streams, dams, or other artificial obstructions which might affect the relation between gage height and discharge.

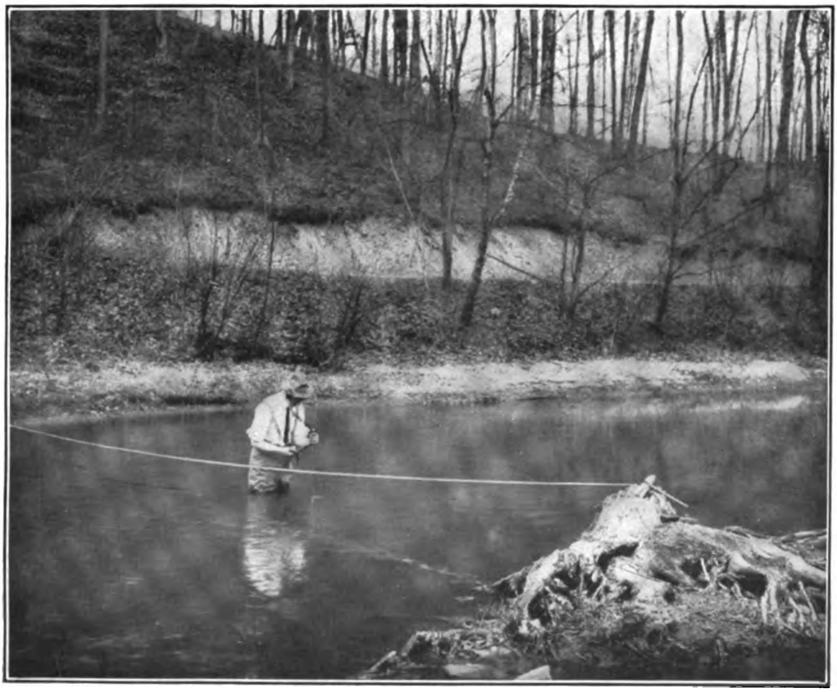
A gaging station consists essentially of a gage for determining the daily fluctuations of stage of the river and some structure or apparatus from which discharge measurements are made, usually a bridge or cable.

The two factors required to determine the discharge of a stream past a section perpendicular to the mean direction of the current are the area of the cross section and the mean velocity of flow normal to that section.

In making a measurement with a current meter a number of points, called measuring points, are measured off above and in the plane of the measuring section at which observations of depth and velocity are taken. (See Pl. I, *A*.) These points are spaced equally for those parts of the section where the flow is uniform and smooth and are spaced unequally for other parts, according to the discretion and judgment of the engineer. In general the points should not be spaced farther apart than 5 per cent of the channel width, nor farther



A. FOR BRIDGE MEASUREMENT.



B. FOR WADING MEASUREMENT.

TYPICAL GAGING STATIONS.

apar
mea
Th
strip
mad
aver
time
The
char
D
sou
swif
bein
sect
T
in g
T
sur
nar
this
to
ice
ren
hig
fac
ren
Th
wh
to
us
be
ar
co
ap

o
d
u

r
l

apart than the approximate mean depth of the section at the time of measurement.

The measuring points divide the total cross section into elementary strips at each end of which observations of depth and velocity are made. The discharge of any elementary strip is the product of the average of the depths at the two ends times the width of the strip times the average of the mean velocities at the two ends of the strip. The sum of the discharges of the elementary strips is the total discharge of the stream.[1]

Depths for the determination of the area are usually obtained by sounding with the current meter and cable. In rough sections or swift currents an ordinary weight and cable are used, particular care being taken that all observations shall be in the plane of the cross section.

Two methods of determining the velocity of flow of a stream are in general use—the float method and the current-meter method.

The float method, with its various modifications of surface, subsurface, and tube or rod floats, is now considered obsolete in the ordinary practice of the United States Geological Survey. The use of this method is limited to special conditions where it is impracticable to use the current meter, such as in places where large quantities of ice or débris which may damage the meter are flowing with the current, and for miscellaneous measurements or other work where a high degree of accuracy is not necessary. Tube floats are very satisfactory for use in canals with regular bottoms and even flow of current. Measurements by the float method are made as follows: The velocity of flow of the stream is obtained by observing the time which it takes floats set free at different points across the stream to pass between two range lines about 200 feet apart. The area used is the mean value obtained from several cross sections measured between the two range lines. The chief disadvantages of this method are difficulty in obtaining the correct value of mean area for the course used and uncertainty regarding the proper coefficient to apply to the observed velocity.[2]

The Price current meter is now used almost to the exclusion of other types of meters by the United States Geological Survey in the determination of the velocity of flow of water in open channels, a use for which it is adapted under practically all conditions.[3]

Plate II shows in the center the new type of penta-recording current meter equipped for measurements at bridge and cable stations; on the left the same type of meter is shown equipped for wading measurements, to record by the acoustic method; on the right the meter is shown equipped to record electrically. (See Pl. I, *B*.) Briefly, the meter consists of six cups attached to a vertical shaft which revolves on a conical hardened steel point when immersed in moving water. The revolutions are indicated electrically. The rating, or relation between the velocity of moving water and the revolutions of the wheel, is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity per second of moving water for any number of revolutions in a given time interval. The ratio of revolutions per second to velocity of flow in feet per second is very nearly a constant for all speeds and is approximately 0.45.

---

[1] For a discussion of methods of computing the discharge of a stream see Engineering News, June 25, 1908.

[2] Further information regarding the float method is given in Water-Supply Paper 95 and the various text-books on stream flow.

[3] See Hoyt, J. C., and others, Use and care of the current meter as practiced by the U. S. Geological Survey: Trans. Am. Soc. Civil Eng., vol. 66, 1910, p. 70.

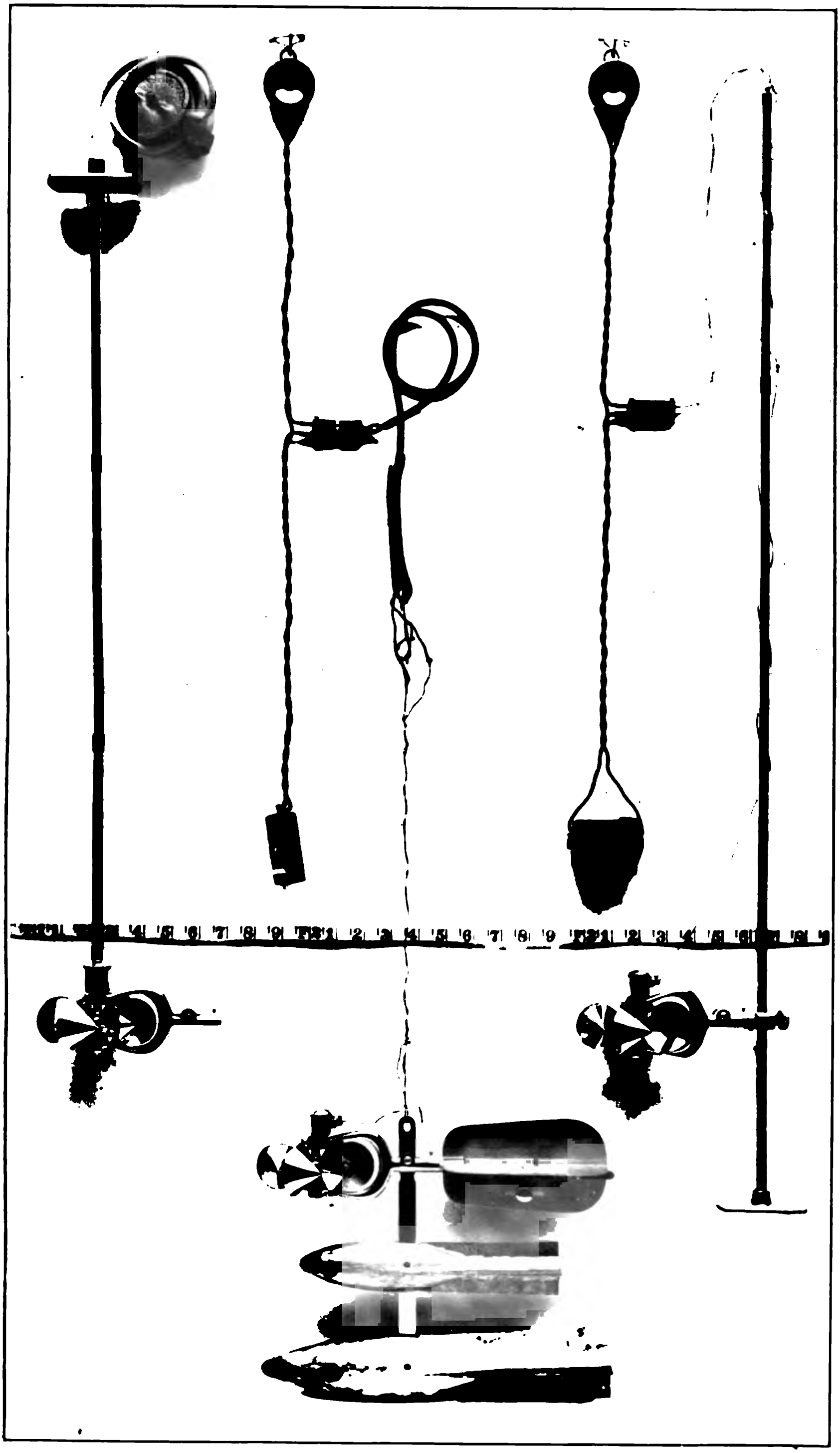
Three classes of methods of measuring velocity with current meters are in general use—multiple-point, single-point, and integration.

The two principal multiple-point methods in general use are the vertical velocity curve and 0.2 and 0.8 depth.

In the vertical velocity curve method a series of velocity determinations are made in each vertical at regular intervals, usually about 10 to 20 per cent of the depth apart. By plotting these velocities as abscissas and their depths as ordinates and drawing a smooth curve among the resulting points, the vertical velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. This method of obtaining the mean velocity in the vertical is probably the best known, but on account of the length of time required to make a complete measurement its use is largely limited to the determination of coefficients for purposes of comparison and to measurements under ice.

In the second multiple-point method the meter is held successively at 0.2 and 0.8 depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. (See Pl. I, *A*.) On the assumption that the vertical velocity curve is a common parabola with horizontal axis, the mean of the velocities at 0.22 and 0.79 depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this multiple-point method gives the mean velocity very closely for open-water conditions and that a completed measurement seldom varies as much as 1 per cent from the value given by the vertical velocity curve method. Moreover, the indications are that it holds nearly as well for ice-covered rivers. It is very extensively used in the regular practice of the United States Geological Survey.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth



SMALL PRICE CURRENT METERS.

for which the coefficient for reducing to mean velocity has been determined or must be assumed.

Extensive experiments by means of vertical velocity curves show that the thread of mean velocity generally occurs between 0.5 and 0.7 total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and at this point the meter is held in most of the measurements made by the single-point method. A large number of vertical velocity curve measurements, taken on many streams and under varying conditions, show that the average coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity. The variation of the coefficient from unity in individual cases is, however, greater than in the 0.2 and 0.8 method, and the general results are not as satisfactory.

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the effect of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocity taken at the subsurface to the mean has been found to be in general from about 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is especially adapted for flood measurements, or when the velocity is so great that the meter can not be kept in the correct position for the other methods.

The vertical integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface and noting the number of revolutions and the time taken in the operation. This method has the advantage that the velocity at each point of the vertical is measured twice. It is useful as a check on the point methods. In using the Price meter great care should be taken that the vertical movement of the meter is not rapid enough to vitiate the accuracy of the resulting velocity.

The determination of the flow of an ice-covered stream is difficult, owing to diversity and instability of conditions during the winter period and also to lack of definite information in regard to the laws of flow of water under ice. The method now employed is to make frequent discharge measurements during the frozen periods by the 0.2 and 0.8 and the vertical velocity curve methods, and to keep an accurate record of the conditions, such as the gage height to the surface of the water as it rises in a hole cut in the ice and the thickness and character of the ice. From these data an approximate estimate of the daily flow can be made by constructing a rating curve (really a series of curves) similar to that used for open channels, but considering, in addition to gage heights and discharge, the varying thickness of ice.[1]

---

[1] For information in regard to flow under ice cover see Water-Supply Paper U. S. Geol. Survey, No. 187.

OFFICE METHODS OF COMPUTING AND STUDYING DISCHARGE AND RUN-OFF.

At the end of each year the field or base data for current-meter gaging stations, consisting of daily gage heights, discharge measurements, and full notes, are assembled. The measurements are plotted on cross-section paper and rating curves are drawn wherever feasible. The rating tables prepared from these curves are then applied to the tables of daily gage heights to obtain the daily discharges, and from these applications the tables of monthly discharge and run-off are computed.

Rating curves are drawn and studied with special reference to the class of channel conditions which they represent. (See p. 17.) The discharge measurements for all classes of stations when plotted with gage heights in feet as ordinates and discharges in second-feet as abscissas define rating curves which are more or less generally parabolic in form. In many cases curves of area in square feet and mean velocity in feet per second are also constructed to the same scale of ordinates as the discharge curve. These are used mainly to extend the discharge curves beyond the limits of the plotted discharge measurements, and for checking purposes to avoid errors in the form of the discharge curve and to determine and eliminate erroneous measurements.

For every rating table the following assumptions are made for the period of application of the table: (*a*) That the discharge is a function of and increases gradually with the stage; (*b*) that the discharge is the same whenever the stream is at a given stage, and hence such changes in conditions of flow as may have occurred during the period of application are either compensating or negligible, except that the rating is not applicable for known conditions of ice, log jams, or other similar obstructions; (*c*) that the increased and decreased discharge due to change of slope on rising and falling stages is either negligible or compensating.

As already stated, the gaging stations may be divided into several classes, as indicated in the following paragraphs:

The stations of class 1 represent the most favorable conditions for an accurate rating and are also the most economical to maintain. The bed of the stream is usually composed of rock and is not subject to the deposit of sediment and loose material. This class includes also many stations located in a pool below which is a permanent rocky riffle that controls the flow like a weir. Provided the control is sufficiently high and close to the gage to prevent cut and fill at the gaging point from materially affecting the slope of the water surface, the gage height will for all practical purposes be a true index of the discharge. Discharge measurements made at such stations usually plot within 2 or 3 per cent of the mean-discharge curve, and the rating developed from that curve represents a very high degree of accuracy. Stations of this type are found in the north Atlantic coast drainage basins.

Class 2 is confined mainly to stations on rough, mountainous streams with steep slopes. The beds of such streams are as a rule comparatively permanent during low and medium stages and when the flow is sufficiently well defined by an adequate number of discharge measurements before and after each flood the stations of this class give nearly as good results as those of class 1. As it is seldom possible to make measurements covering the time of change at flood stage, the assumption is often made that the curves before and after the flood converged to a common point at the highest gage height recorded during the flood. Hence the only uncertain period occurs during the few days of highest gage heights covering the period of actual change in conditions of flow. Stations of this type are found in the upper Missouri River basin.

Class 3 includes most of the current-meter gaging stations maintained by the United States Geological Survey. If sufficient measurements could be made at stations of this class, results would be obtained nearly equaling those of class 1, but owing to the limited funds at the disposal of the Survey this is manifestly impossible, nor is it necessary for the uses to which discharge data are applied. The critical points are, as a rule, at relatively high or low stages. The percentage error, however, is greater at low stages. No absolute rule can be laid down for stations of this class. Each rating curve must be constructed mainly on the basis of the measurements of the current year, the engineer being guided largely by the past history of the station and the following general law: If all measurements ever made at a station of this class are plotted on cross-section paper they will define a mean curve which may be called a standard curve. It has been found in practice that if after a change caused by high stage a relatively constant condition of flow occurs at medium and low stages, all measurements made after the change will plot on a smooth curve which is practically parallel to the standard curve with respect to their ordinates or gage heights. This law of the parallelism of ratings is the fundamental basis of all ratings and estimates at stations with semipermanent and shifting channels. It is not absolutely correct but, with few exceptions, answers all the practical requirements of estimates made at low and medium stages after a change at a high stage. This law appears to hold equally true whether the change occurs at the measuring section or at some controlling point below. The change is, of course, fundamentally due to change in the channel caused by cut, or fill, or both, at or near the measuring section. For all except small streams the changes in section usually occur at the bottom. The following simple but typical examples illustrate this law:

(*a*) If 0.5 foot of planking were to be nailed on the bottom of a well-rated wooden flume of rectangular section there would result, other conditions of flow being equal, new curves of discharge, area, and velocity, each plotting 0.5 foot above the original curves when referred to the original gage. In other words, this condition would be analogous to a uniform fill or cut in a river channel which either reduces or increases all three values of discharge, area, and velocity for any gage height. In practice, however, such ideal conditions rarely exist.

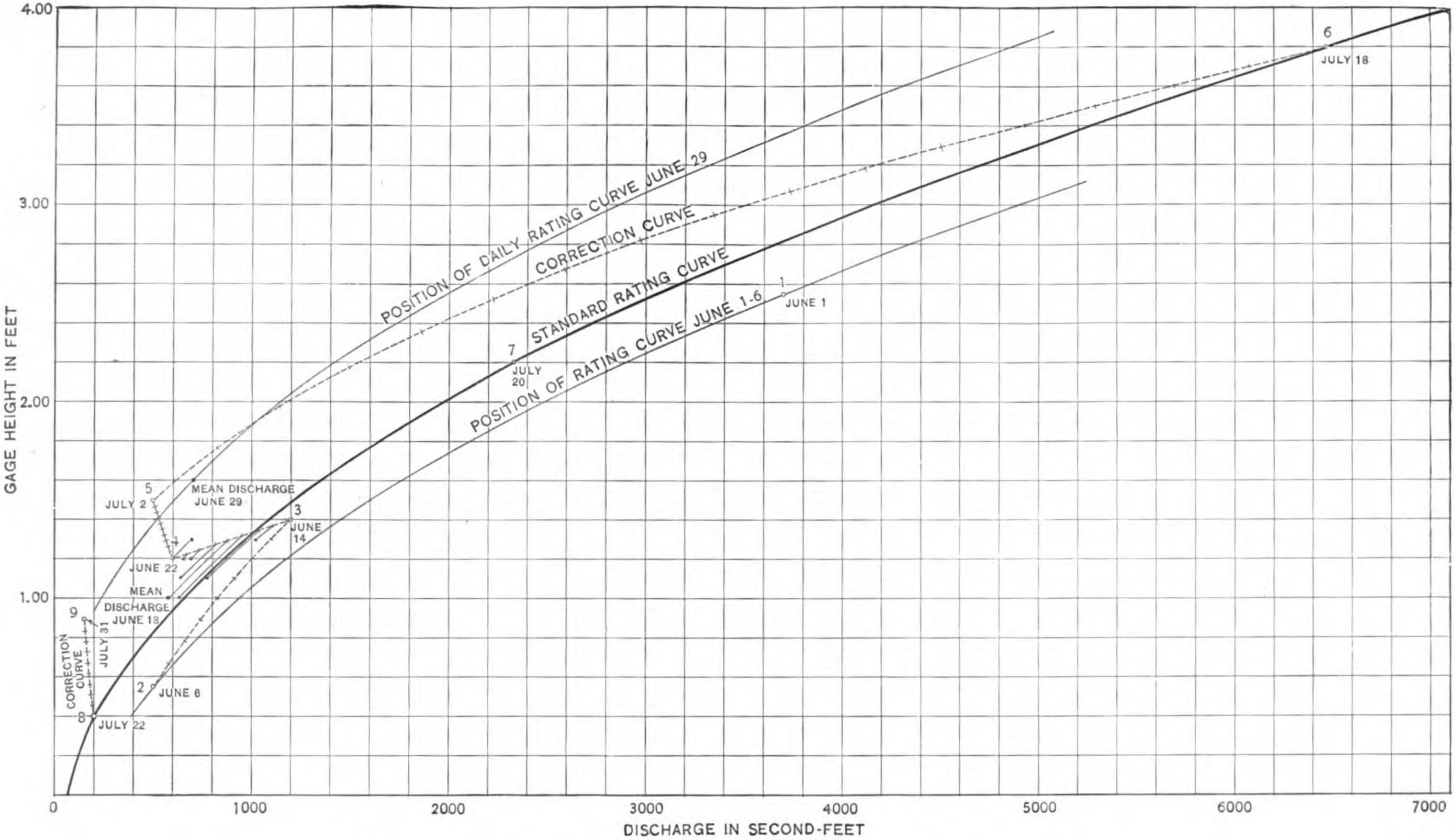
(*b*) In the case of a cut or fill at the measuring section there is a marked tendency toward decrease or increase, respectively, of the velocity. In other words, the velocity has a compensating effect and if the compensation is exact at all stages the discharge at a given stage will be the same under both the new and the old conditions.

(*c*) In the case of uniform change along the crest of a weir or rocky control, the area curve will remain the same as before the change, and it can be shown that here again the change in velocity curve is such that it will produce a new discharge curve essentially parallel to the original discharge curve with respect to their ordinates.

Of course in actual practice such simple changes of section do not occur. The changes are complicated and lack uniformity, a cut at one place being largely offset by a fill at another and vice versa. If these changes are very radical and involve large percentages of the total area—as, for example, on small streams—there may result a wide departure from the law of parallelism of ratings. In complicated changes of section the corresponding changes in velocity which tend to produce a new parallel discharge curve may interfere with each other materially, causing eddies, boils, backwater, and radical changes in slope. In such extreme conditions, however, the measuring section would more properly fall under class 4 and would require very frequent measurements of discharge. Special stress is laid on the fact that in the lack of other data to the contrary the utilization of this law will yield the most probable results.

Slight changes at low or medium stages of an oscillating character are usually averaged by a mean curve drawn among them parallel to the standard curve, and if the individual measurements do not vary more than 5 per cent from the rating curve the results are considered good for stations of this class. Stations of this type are found in the south Atlantic coast drainage basins.

Class 4 comprises stations that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency varying from a measure-



GRAPHIC METHOD OF DETERMINING DAILY DISCHARGE OF STREAMS WITH CHANGEABLE BEDS.

me
to

of
log
the
all
an

str
the
dis
so
wi
sta
tio
in

th
T
p
n
n
d
t
c
u
s

ment every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow.

The following method of determining the daily discharge of streams of this class is now used by the engineers of the United States Geological Survey almost exclusively, owing to the rapidity with which the necessary computations can be made, the clearness with which all changes in conditions of flow, so far as known, can be followed and the accuracy of the results obtained.

In the graphic method of determining the daily discharge of streams with changeable beds, which was devised by R. H. Bolster, the discharge measurements for the entire year are first plotted with discharges as abscissas and gage heights as ordinates. The points so plotted are considered chronologically and, even though scattered, will usually locate one or more fairly well-defined curves, called standard curves. (See Pl. III.) In general, the number and position of these standard curves are determined by the radical changes in the stream bed due to floods.

When stream beds change very rapidly it is necessary to change the position of the rating curve each day, making a new curve daily. This daily curve is of the same form as the standard curve and is parallel to it with respect to ordinates. For a day when a measurement is made the rating curve passes through such plotted measurement, the discharge for the day being read off from the scale of discharge in second-feet at the point of intersection of the curve and the mean gage height for the day. In order to locate the rating curve for other days, curves are drawn connecting consecutive measurements. They are called correction curves and should have the same curvature as that portion of the standard curve which lies vertically above or below them. They are divided into as many equal parts as there are days intervening between the measurements, on the assumption that the change in conditions of flow between any two consecutive measurements is uniform from day to day. The daily rating curve will then pass through these points of division, and the discharge is read directly from these curves at the point of intersection with the observed daily gage height.

In order to facilitate the use of this method and obviate the drawing of daily rating curves, dividers are employed. Care is exercised to keep both points in the same vertical line of discharge, then with one point of the dividers coincident with the standard curve the other can be made to trace any daily rating curve desired.

In applying and modifying the indirect method for shifting channels as above outlined judgment must be used, especially for long-time intervals not covered by discharge measurements, or for radical changes in the stream bed caused by sudden floods. For illustrative examples of stations of this type see Water-Supply Papers 247, 249, and 267.

The computations have, as a rule, been carried to three significant figures. Computation machines, Crelle's tables, and the 20-inch slide rule have been generally used. All computations are carefully checked.

After the computations have been completed they are entered in tables and carefully studied and intercompared to eliminate or account for all gross errors so far as possible. Missing periods are filled in, so far as feasible, by means of comparison with adjacent streams. The attempt is made to complete years or periods of discharge, thus eliminating fragmentary and disjointed records. Full notes accompanying such estimates follow the daily and monthly discharge tables.

For most of the northern stations estimates have been made of the monthly discharge during ice periods. These are based on measurements under ice conditions wherever available, on daily records of temperature and precipitation obtained from the United States Weather Bureau, on climate and crop reports, on observers' notes of conditions, and on a careful and thorough intercomparison of results with adjacent streams. Although every care possible is used in making these estimates they are often very rough, the data for some of them being so poor that the estimates are liable to as much as 25 to 50 per cent error. It is believed, however, that estimates of this character are better than none at all, and serve the purpose of indicating in a relative way the proportionate amount of flow during the ice period. These estimates are, as a rule, included in the annual discharge. The large error of the individual months has a relatively small effect on the annual total, and it is for many purposes desirable to have the yearly discharge computed even though some error is involved in doing so.

ACCURACY AND RELIABILITY OF FIELD DATA AND COMPARATIVE RESULTS.

Practically all discharge measurements made under fair conditions are well within 5 per cent of the true discharge at the time of observation. Inasmuch as the errors of meter measurements are largely compensating, the mean rating curve, when well defined, is much more accurate than the individual measurements. Numerous tests and experiments have been made to test the accuracy of current-meter work. These show that it compares very favorably with the results from standard weirs, and, owing to simplicity of methods, usually gives results that are much more reliable than those from stations at dams, where uncertainty regarding the coefficient and complicated conditions of flow prevail.

The work is, of course, dependent on the reliability of the observers. With relatively few exceptions, the observers perform their work honestly. Care is taken, however, to watch them closely and to inquire into any discrepancies. It is, of course, obvious that one gage reading a day does not always give the mean height for that day. As an almost invariable rule, however, errors from this source are compensating and virtually negligible in a period of one month, although a single day's reading may, when taken by itself, be considerably in error.

The effort is made to visit every station at least once each year for the purpose of making a measurement to determine the constancy of conditions of flow since the last measurement made during the preceding year, and also to check the elevation of the gage. On account of lack of funds or for other causes, some stations were not visited during the current year. If conditions of flow have been reasonably permanent up to the time of the last preceding measurement, it is considered best to publish values of discharge on the basis of the latest verified rating curve rather than to omit them altogether, although it should be distinctly understood that such records are at times subject to considerable error. This is also true, although to a less degree, of the period of records since the date of the last measurement of the current year. As a rule the accuracy notes are based on the assumption that the rating curve used is strictly applicable to the current year.

In order to give engineers and others information regarding the probable accuracy of the computed results, footnotes are added to the daily discharge tables, stating the probable accuracy of the rating tables used, and an accuracy column is inserted in the monthly discharge table. For the rating tables "well defined" indicates in general that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined" or "approximate," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The accuracy column in the monthly discharge table does not apply to the maximum or minimum nor to any individual day, but to the monthly mean. It is based on the accuracy of the rating, the probable reliability of the observer, and knowledge of local conditions. In this column, A indicates that the mean monthly flow is probably accurate within 5 per cent; B, within 10 per cent; C, within 15 per cent; D, within 25 per cent. Special conditions are covered by footnotes.

USE OF THE DATA.

In general the policy is followed of making available for the public the base data which are collected in the field each year by the survey engineers. This is done to comply with the law, but also for the express purpose of giving to any engineer the opportunity of examining the computed results and of changing and adjusting them as may seem best to him. Although it is believed that the rating tables and computed monthly discharges are as good as the base data up to and including the current year will warrant, it should always be borne in mind that the additional data collected at each station from year to year nearly always throw new light on data already collected and published, and hence allow more or less improvement in the computed results of earlier years. It is therefore expected that the engineer who makes serious use of the data given in these papers will verify all ratings and make such adjustments in earlier years as may seem necessary. The work of compiling, studying, revising, and republishing data for different drainage basins for 5 or 10 year periods or more is carried on by the United States Geological Survey so far as the funds for such work are available.

The values in the table of monthly discharge are so arranged as to give only a general idea of the conditions of flow at the station, and it is not expected that they will be used for other than preliminary estimates. The daily discharges are published to allow a more detailed study of the variation in flow and to determine the periods of deficient flow.

COOPERATIVE DATA.

Cooperative data of various kinds and also data regarding the run-off at many stations maintained wholly by private funds are incorporated in the surface water-supply reports of the United States Geological Survey.

Many stations throughout the country are maintained for specific purposes by private parties who supply the records gratuitously to the United States Geological Survey for publication. When such records are supplied by responsible parties and appear to be reasonably accurate they are verified, so far as possible, and estimated values of accuracy are given. Records clearly known to be worthless or misleading are not published. As it is, however, impossible to completely verify all such records furnished—because of lack of funds or for other causes—they are published for what they are worth, as they are of value as a matter of record and afford at least approximate information regarding stream flow at the particular localities. The Survey does not, however, assume any responsibility for inaccuracies found in such records, although most of them are believed to be reasonably good.

COOPERATION AND ACKNOWLEDGMENTS.

Special acknowledgments are due for cooperative assistance as follows:

The Uinta irrigation survey of the United States Indian Office paid the salary and expenses of a hydrographer, amounting to about $2,000, for the stations in the Uinta Reservation, Utah, and that vicinity.

The Central Colorado Power Co. paid the salary and expenses of a hydrographer on cooperative work in the Grand River drainage basin for several months during 1909 and has otherwise materially assisted in the work.

The United States Reclamation Service has furnished all the field data for the stations in the Gunnison drainage basin in Colorado, has paid the expense of maintaining the station on the Grand at Palisades, Colo., and has paid the expense of all hydrometric work in the vicinity of the Strawberry Valley in the Duchesne River drainage basin.

The Territorial engineer of New Mexico, Mr. Vernon L. Sullivan, cooperated in the maintenance of all stations in the Colorado River basin in New Mexico from the sum of $2,500 set aside annually for this work in the Territory by the Territorial legislature, the $1,000 allotted by the Atchison, Topeka & Santa Fe Railway Co. for the work in New Mexico, and from other funds pertaining to his office.

The State engineer of Colorado, Mr. Charles W. Comstock, has assisted materially in carrying on the work in this drainage basin.

Under the provisions of a formal contract between the Director of the United States Geological Survey and the State engineer of Utah, dated July 1, 1909, the sum of $2,000 was to be expended by each party for hydrometric work in the State of Utah during the fiscal year immediately following. The expenditure of this money was so divided as to cover the salary and expenses of hydrographers, the pay of gage readers, the cost of construction, and the cost of preparing the data in the manner most suitable to expedite the work.

The State engineer of Utah, Mr. Caleb Tanner, paid the salaries of the observers at five stations in the Duchesne River drainage in cooperation with the United States Indian Office and the United States Geological Survey.

Mr. Thomas Lyons, of Gila, N. Mex., paid the expenses of a hydrographer and the salary of the gage observer at the station on Gila River at Red Rock and has otherwise contributed to the work.

Mr. R. E. Vickery, of Grand Junction, Colo., has borne the larger part of the expense of maintaining the stations on West Divide and West Mamm creeks.

Assistance was rendered or records furnished by the United States Weather Bureau, the Denver Reservoir & Irrigation Co., the Denver Union Water Co., Prof. George J. Lyon, Mr. G. H. Matthes, Mr. E. C. Jansen, Mr. Stanley Krajicek, Mr. Jay Turley, Mr. M. C. Hinderlider, Mr. G. W. Vallery, Mr. H. F. Robinson, Mr. R. M. Jones, and others.

DIVISION OF WORK.

The field data in the Grand River drainage basin were collected under the direction of W. B. Freeman, district engineer, by J. B. Stewart, G. H. Russell, C. L. Chatfield, W. H. Snelson, the last two of whom are engineers of the Central Colorado Power Co. and the United States Reclamation Service, respectively.

The field data in the Duchesne River drainage basin in the Uinta Indian Reservation were collected under the direction of W. B. Freeman, district engineer, by R. H. Fletcher, who was under the more immediate supervision of H. C. Means, superintendent of irrigation, United States Indian Office.

All field data for the State of Utah, except in the Uinta Indian Reservation, were collected under the direction of E. C. LaRue, district engineer, by E. A. Porter.

The field data for the San Juan and Gila River drainage basins in New Mexico were collected under the general direction of W. B. Freeman, district engineer, by J. B. Stewart, but under the more immediate supervision of Vernon L. Sullivan, Territorial engineer, assisted by C. D. Miller.

The field data for all stations in Arizona, together with the estimates of discharge, except those for Little Colorado River at St. Johns, Ariz., have been furnished by the United States Reclamation Service.

The field data for stations in California have been collected under the direction of W. B. Clapp, district engineer for California, by W. V. Hardy, H. A. Jones, W. F. Martin, and A. H. Hoebig, jr.

The ratings, special estimates, and studies of the completed data were made by W. B. Freeman, R. H. Bolster, and E. S. Fuller. The computations were made and the completed data prepared for publication under the direction of R. H. Bolster, assistant engineer, by R. C. Rice, J. G. Mathers, H. D. Padgett, M. E. McChristie, J. J. Phelan, H. J. Jackson, J. B. Stewart, L. T. King, and M. I. Walters. The report has been edited by Mrs. B. D. Wood.

GAGING STATIONS IN COLORADO RIVER BASIN.

The following is a list of gaging stations maintained in Colorado River basin by the United States Geological Survey and cooperative parties. The stations are arranged by river basins, in downstream order, as explained on page 13, tributaries being indicated by indention. Data for these stations have been published in the reports listed in tables on page 11.

Green River (head of Colorado) at Green River, Wyo., 1895–1906.
Green River at Jensen, Utah, 1903-1906.
Green River at Ouray, Utah, 1904–5.
Green River at Greenriver, Utah, 1894–1899 and 1905–1909.
Colorado River at Hardyville, Ariz., 1905–1907.
Colorado River at Mohave City, Ariz., 1902–3.
Colorado River at Yuma, Ariz., 1895–1909.
  Salton Sea near Salton, Cal., 1904–1909.
    Alamo River near Brawley, Cal., 1908–9.
    New River near Brawley, Cal., 1908–9.
Green River:
  Newfork River at Cora, Wyo., 1905.
    Pine Creek at Pinedale, Wyo., 1904–1906.
    Pole Creek at Fayette, Wyo., 1904–1906.
    Fall Creek at Fayette, Wyo., 1904–5.
    Boulder Creek at Boulder (Newfork), Wyo., 1904–1906.
    Eastfork River at Newfork, Wyo., 1905–6.
  Green River (Black Fork) at Granger, Wyo., 1896–1900.
  Yampa River at Steamboat Springs, Colo., 1904–1906.
  Yampa River at Craig, Colo., 1901–2, 1904-1906.
  Yampa River at Maybell, Colo., 1904–5.
    Elk River at Trull, Colo., 1904–1906.
    Elk Head Creek at Craig, Colo., 1906.
    Fortification Creek at Craig, Colo., 1905–6.
    Williams River at Hamilton, Colo., 1904–1906.
    Milk Creek at Axial, Colo., 1904–5.
    Little Snake River at Maybell, Colo., 1904.
  Ashley Creek at Vernal, Utah, 1900–1904.
    Ashley Creek (Dry Fork) at Vernal, Utah., 1904.
  White River (North Fork) at Buford, Colo., 1903–1906.
  White River at Meeker, Colo., 1901-1906.
  White River at White River City. Colo., 1895.
  White River at Rangely, Colo., 1904–5.
  White River at Dragon, Utah, 1906.
  White River at Ouray, Utah, 1904.
    Marvine Creek near Buford, Colo., 1903–1906.
    White River (South Fork) near Buford, Colo., 1903–1906.
  Duchesne River (North Fork) above Forks, Utah, 1904.
  Duchesne River at Myton, Utah, 1899–1909.
    Duchesne River (West Fork) above Forks, Utah, 1904.
    Rock Creek (East Creek) 10 miles above mouth, Utah, 1904.
    Strawberry River, above mouth of Indian Creek, in Strawberry Valley, Utah, 1909.
    Strawberry River, below mouth of Indian Creek, in Strawberry Valley, Utah, 1903–1906 and 1908–9.
    Strawberry River at Theodore, Utah, 1908–9.
      Indian Creek in Strawberry Valley, Utah, 1905–6 and 1909.
        Trail Hollow Creek in Strawberry Valley, Utah, 1909.
      Currant Creek, 13 miles above mouth, Utah, 1904.
      Currant Creek, 3 miles above mouth, Utah, 1904.
        Red Creek above Narrows, Utah, 1904.

- Green River—Continued.
  - Duchesne River at Myton, Utah—Continued.
    - Lake Fork (West Fork), 10 miles above Forks, Utah, 1904.
    - Lake Fork below Forks, Utah, 1904, 1907–1909.
    - Lake Fork near Myton, Utah, 1900–1904, 1907–1909.
      - Lake Fork (East Fork), 8 miles above Forks, Utah, 1904.
    - Unita River near Whiterocks, Utah, 1899–1904, 1907–1909.
    - Uinta River at Fork Duchesne, Utah, 1899–1904, 1906–1909.
    - Uinta River at Ouray School, Utah, 1899–1904.
      - Whiterocks River near Whiterocks, Utah, 1899–1904, 1907–1909.
  - Price River near Helper, Utah, 1904–1909.
  - San Rafael River near Greenriver, Utah, 1909.
    - Cottonwood Creek near Orangeville, Utah, 1909.
      - Ferron Creek near Ferron, Utah, 1909.
    - Huntington Creek near Huntington, Utah, 1909.
  - Grand River (North Fork) near Grand Lake, Colo., 1904–1909.
  - Grand River near Granby, Colo., 1908–9.
  - Grand River at Sulphur Springs, Colo., 1904–1909.
  - Grand River near Kremmling, Colo., 1904–1909.
  - Grand River near Wolcott, Colo., 1906–1908.
  - Grand River at Shoshone, Colo., 1897.
  - Grand River at Glenwood Springs, Colo., 1899–1909.
  - Grand River near Palisades, Colo., 1902–1909.
  - Grand River near Grand Junction, Colo., 1895–1900.
    - North Inlet to Grand Lake at Grand Lake, Colo., 1905–1909.
    - Grand Lake Outlet at Grand Lake, Colo., 1904–1909.
    - Grand River (South Fork) near Lehman, Colo., 1907–8.
    - Fraser River at Granby (Coulter), Colo., 1904–1909.
    - Fraser River at upper station near Fraser, Colo., 1908–9.
    - Fraser River at lower station near Fraser, Colo., 1907–1909.
      - Big Jim Creek near Fraser, Colo., 1907–1909.
        - Little Jim Creek near Fraser, Colo., 1907–1909.
      - Vasquez Creek at upper station near Fraser, Colo., 1908–9.
      - Vasquez Creek at lower station near Fraser, Colo., 1907–1909.
      - Elk Creek near Fraser, Colo., 1907–1909.
      - St. Louis Creek at upper station near Fraser, Colo., 1908–9.
      - St. Louis Creek at lower station near Fraser, Colo., 1908–9.
      - North Ranch Creek at upper station near Rollins Pass, Colo., 1908–9.
      - North Ranch Creek at lower station near Rollins Pass, Colo., 1907–1909.
        - Middle Ranch Creek at upper station near Arrow, Colo., 1908–9.
        - Middle Ranch Creek at lower station near Arrow, Colo., 1907–1909.
          - South Ranch Creek at upper station near Arrow, Colo., 1908–9.
          - South Ranch Creek at lower station near Arrow, Colo., 1907–1909.
    - Williams Fork near Sulphur Springs, Colo., 1904–1909.
    - Troublesome River at Troublesome, Colo., 1904–5.
    - Muddy River at Kremmling, Colo., 1904–5.
    - Blue River near Kremmling, Colo., 1904–1908.
      - Tenmile Creek near Kokomo, Colo., 1904.
      - Tenmile Creek near Uneva Lake, Colo., 1903.
    - Eagle River near Eagle, Colo., 1905–1907.
    - Eagle River at Gypsum, Colo., 1907–1909.
    - Roaring Fork near Emma, Colo., 1908–9.

- Green River—Continued.
  - Grand River near Grand Junction, Colo.—Continued.
    - Roaring Fork at Glenwood Springs, Colo., 1906–1909.
      - Frying Pan River at Basalt, Colo., 1908–9.
      - Crystal River near Carbondale (Sewell), Colo., 1908–9.
    - West Divide Creek at Hostutler's ranch, near Raven, Colo., 1909.
    - West Divide Creek near Raven, Colo., 1909.
    - West Mamm Creek near Rifle, Colo., 1909.
    - Gunnison River near Iola, Colo., 1900–1903.
    - Gunnison River near Cimarron, Colo., 1903–1905.
    - Gunnison River at River Portal (east portal of Gunnison Tunnel), Colo., 1905–1909.
    - Gunnison River near Cory, Colo., 1903–1905.
    - Gunnison River at Roubideau, Colo., 1897.
    - Gunnison River at Whitewater, Colo., 1897, 1901–1906.
    - Gunnison River near Grand Junction, Colo., 1895, 1897–1899.
      - Taylor River near Almont, Colo., 1905.
        - East River at Almont, Colo., 1905.
      - Cimarron Creek at Cimarron, Colo., 1903–1905.
      - Gunnison River (North Fork) near Hotchkiss, Colo., 1903–1906.
      - Uncompahgre River near Colona, Colo., 1903–1906.
      - Uncompahgre River near Ouray, Colo., 1908.
      - Uncompahgre River at Fort Crawford, Colo., 1895–1899, 1908.
      - Uncompahgre River at Montrose, Colo., 1900, 1903–1909.
      - Uncompahgre River at Delta, Colo., 1903–1909.
    - Dolores River near Dolores, Colo., 1895–1903.
      - San Miguel River near Fall Creek, Colo., 1895–1899.
- Colorado River:
  - Fremont River near Thurber, Utah, 1909.
    - Muddy Creek near Emery, Utah, 1909.
  - Escalante Creek near Escalante, Utah, 1909.
  - San Juan River near Arboles, Colo., 1895–1899.
  - San Juan River at Turley, N. Mex., 1907–8.
  - San Juan River at Blanco, N. Mex., 1908–9.
  - San Juan River near Bloomfield, N. Mex., 1909.
  - San Juan River near Farmington, N. Mex., 1904–1906.
    - Piedra River near Arboles, Colo., 1895–1899.
    - Los Pinos River at Ignacio, Colo., 1899–1903.
    - Animas River at Silverton, Colo., 1903.
    - Animas River at Durango, Colo., 1895–1905.
    - Animas River at Aztec, N. Mex., 1904, 1907–1909.
    - Animas River near Farmington, N. Mex., 1904–5.
      - Florida River near Durango, Colo., 1899, 1901–1903.
    - La Plata River at Hesperus, Colo., 1904–1906.
    - La Plata River at La Plata, N. Mex., 1905–1909.
    - Mancos River at Mancos, Colo., 1898–1900.
  - Little Colorado at St. Johns, Ariz., 1906–1909.
  - Little Colorado at Woodruff, Ariz., 1905–1908.
  - Little Colorado at Holbrook, Ariz., 1905–1909.
    - Silver Creek at Snowflake, Ariz., 1906–1908.
    - Silver Creek at Canyon Station, Ariz., 1906.
    - Woodruff ditch at Woodruff, Ariz., 1906.

Colorado River—Continued.
  - Little Colorado at Holbrook, Ariz.—Continued.
    - Chevelon Fork near Winslow, Ariz., 1906–1908.
    - Clear Creek near Winslow, Ariz., 1906–1909.
  - Virgin River at Virgin, Utah, 1909.
    - Santa Clara River near Central, Utah, 1909.
    - Santa Clara River near St. George, Utah, 1909.
    - Muddy River near Moapa, Nev., 1904–1906, and 1909.
  - Gila River near Cliff, N. Mex., 1904–1907.
  - Gila River near Redrock, N. Mex., 1908–9.
  - Gila River at San Carlos, Ariz., 1899–1905.
  - Gila River near Buttes, Ariz., 1889–1890, and 1895–1899.
  - Gila River at Dome (Gila City), Ariz., 1903–1906.
    - San Francisco River at Alma, N. Mex., 1904–1907, and 1909.
    - San Pedro River at Charleston, Ariz., 1904–1906.
    - San Pedro River near Dudleyville, Ariz., 1890.
    - Santa Cruz River near Nogales, Ariz., 1907–1909.
    - Santa Cruz River and ditches at Tucson, Ariz., 1905–1909.
      - Queens Creek at Whitlow's, Ariz., 1896.
    - Salt River at Roosevelt, Ariz., 1901–1907.
    - Salt River below mouth of Cherry Creek, near Roosevelt, Ariz., 1906.
    - Salt River 50 miles above Phoenix, Ariz., 1890.
    - Salt River at Arizona dam, Ariz., 1888–1891.
    - Salt River at McDowell, Ariz., 1888–1909.
      - Tonto Creek at Roosevelt, Ariz., 1901–1904.
      - Verde River at McDowell, Ariz., 1888–1909.

Canal stations in Colorado River Basin:
  - Imperial Canal (main) near Calexico, Cal., 1904–5.
  - Boundary Canal near Calexico, Cal., 1905.
  - Wisteria Canal near Calexico, Cal., 1905.
  - Imperial Canal 10 miles below Yuma, Ariz., Mexican boundary line, 1903–1905.
  - Holt Canal at Calexico, Cal., 1904–5.
  - Hemlock Canal at Calexico, Cal., 1904–5.
  - Alamo Channel near Calexico, Cal., 1904.
  - Alamitos Canal near Calexico, Cal., 1904–5.

GENERAL FEATURES OF COLORADO RIVER BASIN.

Colorado River is formed in the southeastern part of Utah by the junction of Grand and Green rivers. The Green is larger than the Grand and is the upward continuation of the Colorado. Including the Green, the Colorado is about 2,000 miles long. The region drained is about 800 miles long, ranges in width from 300 to 500 miles, and contains about 300,000 square miles. It comprises the southwestern part of Wyoming, the western part of Colorado, the eastern half of Utah, practically all of Arizona, and small portions of California, Nevada, New Mexico, and old Mexico. Most of this area is arid, the mean annual rainfall being about 8½ inches. The streams receive their supply from the melting snows on the high mountains of Wyoming, Utah, and Colorado.

The basin comprises two district portions. The lower third is but little above the level of the sea, though here and there ranges of mountains rise to elevations of 2,000 to 6,000 feet. This part of the valley is bounded on the north bv a line of cliffs which present a bold and in many places vertical step of hundreds or thousands of feet to the tableland above. The upper two-thirds of the basin stands from 4,000 to 8,000 feet above sea level, and is bordered on the east, west, and north by ranges of snow-clad mountains, which attain altitudes ranging from 8,000 to 14,000 feet above sea level. Through this plateau the Colorado and its tributaries have cut narrow gorges or canyons in which they flow at almost inaccessible depths. At points where lateral streams enter, the canyons are broken by narrow transverse valleys, diversified by bordering willows, clumps of box elder, and small groves of cottonwood. The whole upper basin of the Colorado is traversed by a labyrinth of these canyons, most of which are dry during the greater portion of the year, and carry water only during the melting of the snow and the brief period of the autumnal and spring rains.

GREEN RIVER AND THE MAIN COLORADO RIVER.

DESCRIPTION.

Green River and its tributaries[1] drain an area rudely triangular in outline, bounded on the north and east by the Wind River Mountains and the ranges forming the Continental Divide, on the south and east by the White River Plateau and the Roan or Book Cliffs, and on the north and west by the Gros Ventre and Wyoming mountains and the great Wasatch Range. The greatest length of the basin, north and south, is about 370 miles. In an east-west direction it measures at its widest part about 240 miles. The total drainage area is approximately 41,000 square miles, and altitudes range from 14,000 feet in the high mountains to about 3,800 feet at the mouth of the Grand.

The area includes a large part of western Wyoming, northwestern Colorado, and eastern Utah. The Uinta and Uncompahgre Indian reservations are located in this basin in northeastern Utah.

The river heads on the western slope of the Wind River Mountains in western Wyoming, its ultimate source being a number of small lakes fed by the glaciers and immense snow deposits always to be found on Fremont and neighboring peaks. For perhaps 25 miles the river flows northwestward through the mountains. It then turns abruptly and runs in a general southerly direction across western Wyoming into Utah. A few miles below the Wyoming-Utah boundary another sharp turn carries the river eastward near the east end of the range. It then flows southward in Colorado for about 25 miles, turns back into Utah, and continues to flow in a southwesterly and southerly direction until it unites with the Grand to form the Colorado. Its length, measured roughly along the course, is approximately 425 miles.

---

[1] The geology of this basin is described in the Eleventh Ann. Rept. U. S. Geol. and Geog. Survey Terr., for 1877, pp. 509-646. Information in regard to the hydrography is contained in the first to fourth annual reports of the Reclamation Service and in United States Geological Survey reports.

The topography of the headwater region is rugged in the extreme. The Wind River Range on the east, and the Gros Ventre and Wyoming ranges on the southwest and west gradually close in as they extend southward, forming a basin approximately 7,450 square miles in extent above the discontinued gaging station at Green River, Wyo.

The upper part of this basin is very narrow, but southward the valley opens out; near Fontanelle, Wyo., it is several miles wide, and its benches and rolling table-lands extend westward to the foothills of the Wyoming Range and eastward to the bluffs which hug the east bank of the river. At Green River the valley is again narrow—only a few hundred yards in width—and for some distance southward the river runs between bluffs standing so close together that no flood plain is seen. Throughout much of its course in Utah the Green flows through a succession of long, deep, narrow canyons with walls ranging in height from a few hundred to as many thousand feet, separated by short valleys containing small tracts of arable lands.

In its upper course the Green receives as tributaries numerous streams heading in the Wind River, Gros Ventre, and Wyoming ranges of mountains, some of them extending so far back into the abrupt, ragged canyons that they dovetail with streams flowing in the opposite direction. The most important of these tributaries are New Fork River, Big Sandy Creek, Labarge Creek, Fontenelle Creek, Black Fork, and Henry Fork. South of the Uinta Mountains the first large stream flowing into the Green is the Yampa, which comes in from the east at the point where the Green turns westward to reenter Utah after its southward journey in Colorado. Farther south Ashley Creek and Duchesne and White rivers discharge their waters into the Green, Ashley Creek and the Duchesne from the west and the White from the east. Below this point the only tributaries of importance are Price, Minnie Maud, and San Rafael rivers, which enter from the west, the San Rafael at a point about 32 miles above the junction of the Green and the Grand.

In the 41,000 square miles which comprise the total drainage area of Green River there are considerably over 5,000 square miles of timbered land in addition to a considerable woodland area. The principal species of mountain timber are the Engelmann spruce and lodgepole pine.

Except for the timber in the high mountains at the headwaters of Green River in Wyoming, the upper portion of the stream is not very extensively forested. The timbered land in that section includes probably 1,500 square miles, with an average stand of about 4,000 feet b. m. per acre. Numerous tracts of irrigated and cultivated land extend from the Wyoming line up the river to elevations of 7,000 feet.[1] In the Green River basin in Utah above the mouth of the Duchesne there are about 600 square miles of timbered land, with an average stand of nearly 3,000 feet b. m. per acre. In the drainage basins of the White and Yampa rivers in Colorado there are nearly 2,000 square miles of timbered area and woodland.

Over the plains portions of the basin, which includes considerably over half of it, the average annual precipitation is probably less than 10 inches annually; over much of the remainder the rainfall averages between 10 and 15 inches; and in only a very small area in the high mountains does the annual precipitation exceed 20 inches.

Throughout this basin the winters are severe and most of the streams have a heavy ice cover for several months. There is usually an abundance of snow in the high mountains, but the winters on the plains are frequently open.

The oldest and most extensive irrigation development in this basin is on the upper Green River in Wyoming. Recently large irrigation systems have been constructed in the Duchesne River basin. Considerable irrigation is practiced around Vernal, Utah, and also in the vicinity of Greenriver, Utah, along the line of the Denver & Rio Grande Railroad. Along White and Yampa rivers in Colorado meadow irrigation is extensively practiced, and projects are now on foot for the irrigation of 200,000 or 300,000 acres of land in that section.

Excellent reservoir sites are found on the headwaters of the Green River and its upper tributaries, and also along Yampa and White rivers on Ashley Creek, and other tributaries in the northwestern corner of Utah, and at the headwaters of Duchesne River. A very considerable portion of the flow could be equalized by storage.

The waters of this stream and its tributaries are practically unused except for irrigation. Not a water-power plant of any importance exists in the whole drainage area of Green River, though splendid opportunities are presented at the headwaters of many of the tributary streams above all irrigation diversions. Theoretically it would be possible at the present time, by utilizing known storage sites, to develop about 1,500,000 horsepower in the basin of the Green. From Wells, Wyo., to the Wyoming State line, a distance of 225 miles, the stream has an average fall of 11 feet per mile; and from the Wyoming State line to the mouth of Minnie Maud Creek, a distance of 200 miles the average fall is 7 feet to the mile.

---

[1] See also description of New Fork drainage basin in Water-Supply Paper 175, pp. 21-22.

From the junction of Green and Grand rivers the Colorado flows southwestward, passes across the northwestern corner of Arizona, then turns to the south and for the remainder of its course forms a part of the southeastern boundary of Nevada and California and the western boundary of Arizona. It empties into the Gulf of California about 60 miles below Yuma, Ariz. The canyons through which it flows are world famed and need not here be described.

The Colorado has been called the Nile of America, and like the Nile it is subject to an annual summer rise which comes at the time when the water is most needed for irrigation. It is interesting to compare the Colorado with the Nile and the Susquehanna. The Nile is similar in type; the Susquehanna shows the difference in flow between arid and humid regions. In the comparison a normal year, based on a 10-year record for Colorado and Susquehanna rivers and such data as could be found in regard to the Nile, have been used. The Colorado has been taken as the standard of comparison.

The Nile has 5.7 times the drainage area and the Susquehanna about one-eighth the area of the Colorado.

The rainfall in the Nile basin is 3.8 times greater; that in the Susquehanna basin is 4.5 times greater. The run-off per square mile from the Nile basin is 1.9 times greater; that from the Susquehanna basin is 37 times greater. The ratio of run-off to rainfall in the Nile basin is 2 times smaller; that of the Susquehanna basin is 8.2 times greater.

The discharge of the Nile is 10.8 times greater; that of the Susquehanna is 4.5 times greater.

The maximum flow of the Colorado is from 70,000 to 110,000 second-feet and occurs in May, June, or July; for the Nile it is about 353,000 second-feet and occurs about the 1st of September; for the Susquehanna it is from 200,000 to 400,000 second-feet and occurs during March, April, and May.

The minimum flow of the Colorado is from 2,500 to 3,000 second-feet and occurs during January and February; that of the Nile is about 14,500 second-feet and occurs about the end of May; for the Susquehanna it is from 2,500 to 5,000 second-feet and occurs in September and October.

The mean flow of the Colorado is about 10,700 second-feet; for the Nile it is about 115,800 second-feet; for the Susquehanna it is about 43,000 second-feet.

The water of the Colorado carries an immense amount of sediment, reaching as high as 2,000 parts of sediment to 100,000 parts of water. Prof. R. H. Forbes, in Bulletin 44 of the University of Arizona Agricultural Experiment Station, says:

> On the basis of the profile, constructed from available data for the volume of flow of the Colorado and of the year's silt determinations made in the laboratory, it is esti-

mated conservatively that the river during 1900 brought down about 61,000,000 tons of sedimentary material, which, condensed to the form of solid rock, is enough to cover 26.4 square miles 1 foot deep, or to make about 164 square miles of recently settled, submerged mud 1 foot deep, reckoning the whole amount of mud for the year to average 6.2 times the bulk of the solid sediment.

A comparatively small amount of land is irrigated by the waters of the Colorado because the stream and its tributaries are situated so far below the level of the irrigable lands as to render their diversion extremely difficult or impracticable. Two pumping plants are in operation to lift water for irrigation at Yuma, and several at other points on the river above Yuma. The Imperial canal diverts water from the river at a point about 10 miles, by river, below Yuma.

The principal tributaries of the Colorado below the Grand and Green are San Juan, Little Colorado, Williams Fork, and Gila rivers, which enters from the east, and Virgin River, which enters from the west. With the exception of Williams Fork, these streams and their tributaries are described in other parts of this report.

GREEN RIVER AT GREENRIVER, UTAH.

This station, which is located at the Rio Grande Western Railway bridge, at Greenriver railroad station, near Elgin post office (originally called Blake), in latitude 39° N., longitude 110° 9′ W., in the San Rafael quadrangle of the United States Geological Survey, was established October 21, 1894, discontinued in November, 1896, and reestablished in February, 1905.

Price River enters from the west about 16 miles above the station. Several irrigation projects are completed and being promoted in this drainage basin. The last diversion above the station is about 10 miles upstream; no water is diverted below the station.

At low and medium stages measurements are made from a ferryboat, at a point about 450 feet above the bridge. At high stages measurements are made from the bridge.

The bed of the river at the bridge is mainly rock; but at low stages it is overlain in places with silt, which scours out and thus causes the changes in conditions of flow, necessitating new ratings at frequent intervals.

A new bridge was erected at this point between the periods of maintenance of the original station and the present one. The present datum, as near as can be learned, is 1.68 feet below the original datum; but owing to change in conditions of flow, due to the relocation of the bridge piers, it is impossible to utilize the early measurements in studies of new discharge curves. The datum of the present chain gage has remained the same since its establishment.

A careful determination, in 1909, of the angle, which the bridge makes with the main current, necessitated a correction of 15 per cent in all discharge measurements made at the bridge from 1905 to 1909. The daily and monthly estimates of discharge have been revised and supersede those previously published.

Ice usually exists at the station during December, January, and February. Conservative monthly estimates during these periods have been obtained by a consideration of the general behavior of the river at this station and by the aid of climatologic data.

Daily gage height, in feet, of Green River at Greenriver, Utah, for 1909.

[L. H. Greene, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.3	5.45	4.9	7.55	7.9	11.2	12.5	7.95	8.8	6.2	5.7	6.2
2	4.5	5.3	4.8	7.35	8.3	11.4	12.25	7.85	8.9	6.2	5.65	5.95
3	4.6	5.3	4.9	7.2	8.35	11.3	12.15	7.65	8.45	6.2	5.6	5.75
4	4.6	5.1	5.0	7.0	8.25	11.15	12.05	7.6	7.8	6.15	5.65	5.6
5	4.6	5.0	5.3	6.95	8.05	11.1	11.9	7.5	7.65	6.1	5.7	5.2
6	4.6	5.0	5.2	6.8	7.65	11.45	11.75	7.4	7.85	6.1	5.7	4.85
7	4.8	4.9	5.35	7.3	7.7	12.05	11.8	7.3	8.2	6.1	5.7	4.65
8	4.9	4.8	5.55	8.0	8.05	12.5	11.65	7.3	8.0	6.0	5.7	4.55
9	5.0	4.8	5.75	8.1	8.5	12.85	11.65	7.35	7.8	6.0	5.7	4.45
10	5.1	4.7	5.9	7.65	9.15	13.65	11.6	7.3	7.6	6.0	5.7	4.3
11	5.1	4.7	6.0	7.1	9.4	14.3	11.3	7.2	7.6	5.95	5.7	4.25
12	5.2	4.8	6.1	7.0	9.55	14.8	10.85	7.1	7.85	5.95	5.7	4.45
13	5.2	4.8	6.0	6.8	10.05	15.15	10.65	7.1	8.0	5.8	5.7	4.55
14	5.3	4.85	6.1	6.35	9.95	14.9	9.95	7.0	7.9	5.9	5.65	4.75
15	5.3	4.8	6.25	6.2	10.2	14.25	9.65	7.0	7.6	5.95	5.6	5.0
16	5.2	4.9	6.1	6.3	9.95	13.8	9.45	7.75	7.35	6.0	5.6	5.0
17	5.0	5.0	5.95	6.45	9.85	13.25	9.25	8.25	7.25	6.0	5.6	5.7
18	5.0	5.0	5.8	6.55	9.7	12.8	9.0	8.05	7.15	6.1	5.5	6.0
19	5.1	4.95	5.95	6.95	9.6	12.65	8.9	8.0	7.0	6.05	5.5	6.1
20	5.1	4.9	6.05	7.45	9.7	12.85	8.85	7.9	7.0	5.9	5.45	6.2
21	5.05	5.0	6.75	8.65	9.7	13.0	8.65	7.75	6.9	5.85	5.4	6.3
22	5.1	5.1	7.7	8.6	9.9	13.2	8.35	7.9	6.8	5.8	5.4	6.35
23	5.1	5.2	9.1	8.3	10.25	13.15	8.4	7.8	6.7	5.7	5.5	6.45
24	5.35	5.1	11.15	8.0	10.4	13.3	8.55	7.6	6.6	5.7	5.55	6.5
25	5.4	5.0	9.8	7.65	10.6	13.55	8.35	7.35	6.6	5.75	5.6	6.6
26	5.15	4.9	9.2	7.35	10.75	13.5	8.3	7.25	6.5	5.8	5.5	6.6
27	5.35	4.9	8.85	7.0	11.1	13.5	8.2	7.2	6.5	5.75	5.5	6.6
28	5.6	4.85	8.55	7.35	11.05	13.45	8.2	7.1	6.4	5.7	5.6	6.6
29	5.75	....	8.35	7.25	10.65	12.9	8.1	7.0	6.35	5.7	5.6	6.6
30	5.8	....	7.95	7.0	10.8	12.75	8.1	7.15	6.3	5.7	5.8	6.6
31	5.7	....	7.7	....	10.9	....	8.0	7.4	....	5.7	....	6.6

NOTE.—Gage heights affected by ice after December 11, 1909.

Daily discharge, in second-feet, of Green River at Greenriver, Utah, for 1905-1909.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1905.										
1	1,760	2,900	6,360	22,500	13,400	3,840	1,870	6,190	1,990	1,870
2	1,870	3,180	6,870	21,400	12,900	3,720	1,870	4,180	2,060	1,760
3	1,870	3,280	8,920	22,800	12,400	3,720	1,870	3,500	1,930	1,550
4	2,050	2,900	10,100	24,500	12,100	3,720	1,870	3,390	1,820	1,370
5	2,120	2,720	11,600	27,000	11,800	3,720	2,060	2,990	2,060	1,370
6	2,120	2,720	12,400	28,400	11,300	3,720	2,060	2,900	2,190	1,290
7	2,340	2,720	12,100	28,800	10,800	3,500	3,080	2,640	2,120	1,290
8	2,720	2,720	10,800	30,200	10,300	3,280	2,640	2,560	2,120	1,220
9	2,900	2,900	9,380	32,000	9,850	3,080	2,480	2,340	2,260	1,220
10	3,500	2,720	8,920	33,900	9,380	3,080	2,640	2,410	2,120	1,220
11	3,840	2,720	8,040	33,500	8,920	2,900	2,810	2,560	1,990	1,290
12	3,720	2,810	8,040	30,200	8,260	2,810	2,810	2,410	1,930	1,330
13	3,390	3,180	8,920	31,300	7,630	2,720	2,480	2,260	1,870	1,370
14	3,180	3,720	10,600	31,300	7,440	2,720	2,340	2,340	1,820	1,370
15	3,080	4,060	9,620	29,500	6,700	2,720	2,060	2,120	1,990	1,370
16	3,080	4,700	8,700	28,800	6,520	2,720	1,990	2,120	1,990	1,290
17	3,080	4,430	8,040	24,200	6,360	2,640	1,870	2,120	1,990	1,370
18	3,080	4,430	8,040	24,500	6,030	2,480	1,990	2,120	1,990	1,370
19	3,080	5,400	8,040	23,800	5,870	2,260	2,120	1,990	1,870	1,370
20	3,280	5,400	8,920	23,100	5,710	2,260	1,990	1,870	1,870	1,370
21	3,180	4,840	10,800	21,800	5,550	2,260	2,190	1,870	1,990	....
22	3,610	4,700	13,700	20,400	5,550	2,260	2,260	1,990	2,560	....
23	3,720	4,970	16,000	19,700	5,250	2,260	2,410	2,060	2,340	....
24	3,500	5,110	18.100	18,800	5,250	1,990	2,260	1,990	2,260	....
25	3,280	5,400	20,100	18,400	4,970	1,990	2,560	1,990	2,120	....
26	3,280	5,400	21,800	17,200	4,840	2,190	2,640	1,990	1,990	....
27	3,280	4,970	23,100	16.600	4,700	2,190	2,900	1,990	2,060	....
28	3,280	5,110	24,200	15.400	4,430	1,990	2,990	1,990	2,190	....
29	3,280	5,710	23,100	14.800	4,300	1,990	4,060	1,990	2,120	....
30	3,080	6,360	23.100	14,000	4,180	1,930	6,030	1,990	1,990	....
31	3.080	....	22,800	....	4,180	1,870	....	1,990	....	....

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1906.											
1	1,740	1,870	12,100	14,200	33,900	14,200	7,840	6,700	3,720	3,080	1,700
2	1,820	1,870	11,600	13,400	35,400	14,800	8,260	7,440	3,500	5,870	1,820
3	1,700	1,870	9,380	13,100	36,800	15,400	7,840	6,870	3,500	4,700	2,120
4	1,700	2,190	8,470	12,600	39,100	15,700	8,040	6,360	3,500	4,970	2,990
5	1,650	2,260	8,040	12,600	41,400	15,700	7,240	6,360	3,500	4,970	3,280
6	1,700	2,340	7,630	12,400	41,000	15,700	7,060	6,520	3,280	4,560	3,080
7	1,990	2,410	7,060	12,900	40,200	15,700	6,870	6,520	3,280	4.060	3,080
8	1,600	2,480	5,550	13,400	41,000	15,700	6,520	6,030	3,180	3,720	3,280
9	1.650	2,640	5,550	13,700	42,100	15.100	6,190	5,550	3,080	3,720	2,810
10	1,500	2,640	5,400	14,000	42,100	15,100	6,030	5,250	3,080	3,720	2,560
11	1,600	2,640	6,030	17,800	39,900	15.700	5,710	5,110	3,080	3,720	2,410
12	1,550	3,180	7,060	20,100	38,300	15.700	5,250	4,700	3,080	3,610	2,640
13	1,500	3,950	6,870	21,700	30,200	15,400	5,250	4,430	3,080	3,500	2,560
14	1,500	5,250	6,870	25,200	27,700	15,100	5,250	4,180	2,900	3,500	2,410
15	1,600	5,550	7,240	30,200	26,300	15,100	5,400	4,060	2,900	3,280	2,560
16	1,600	5,400	8,700	32,000	25,200	14,800	4,970	4,560	2,900	3,280	2,480
17	1,550	4,970	8,470	31,300	24,500	14,500	4,970	4,300	2,900	3,280	2,260
18	1,550	4,430	8,260	30,600	25,600	14,500	4,840	4,700	2,900	3,180	2,120
19	1,700	4,180	8,470	31,300	25,600	14,000	4,430	5,250	2,720	3,080	1,990
20	1,760	3,720	8,700	30,600	25,200	14,200	4,430	4,560	2,720	2,810	1,820
21	1,820	2,990	8,260	31,000	26,300	13.700	4,700	4,560	2,720	2,480	1,760
22	1,820	3,390	9,850	31,700	25,900	12,900	5,550	5,400	2,900	2,260	1,820
23	1,820	4,060	11,600	32,400	24.900	12,100	6,700	4,700	2,900	1,870	1,820
24	1,820	4,970	12,600	33,100	25.600	10,800	7,440	4,430	2,900	1,760	1,820
25	1,820	6,030	13,100	33,100	25,900	10,300	6,360	4,430	2,900	1,870	2,190
26	1,820	9,620	14,000	33,100	26,700	10,300	5,870	4,180	2,900	2,260	2,560
27	1,820	14,800	13,700	32,400	27,400	9,620	5,710	3,950	2,810	2,410	2,560
28	1,760	21,800	14,500	33,100	25,900	9.380	6,360	3,840	2,720	2,340	2,560
29	....	20,400	16,900	34,200	24.500	8,920	6,520	3.720	2,560	2,060	2,720
30	....	18,800	15,400	34,400	25,600	8,260	7,060	3,720	2,720	1,820	2,640
31	....	16,600	....	36,500	....	8,040	6,700	....	2,900	....	2,900

Daily discharge, in second-feet, of Green River at Greenriver, Utah, for 1905–1909—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	2,900	2,720	8,040	9,380	15,100	31,600	38,400	19,300	6,900	3,450	3,000	1,890
2	2,810	2,640	7,440	8,700	15,700	30,200	38,400	18,100	6,900	3,110	3,000	1,740
3	2,720	2,560	7,440	7,840	16,600	29,800	38,100	17,100	6,900	3,000	3,000	1,890
4	2,640	2,560	6,700	7,060	16,600	29,800	39,200	16,500	6,900	3,220	3,000	1,820
5	2,560	2,720	6,030	6,870	16,000	33,000	39,900	16,200	7,940	3,690	3,000	1,740
6	2,560	2,990	5,550	6,030	15,100	36,600	41,400	15,200	6,500	3,820	3,000	1,740
7	2,340	3,080	5,110	6,030	14,800	40,700	42,100	14,600	6,310	3,940	3,000	1,600
8	2,120	3,720	5,250	7,240	14,200	42,500	42,900	14,000	6,120	3,940	3,000	1,600
9	2,340	4,300	4,840	8,700	14,000	44,800	42,900	14,000	6,120	3,690	3,000	1,600
10	2,560	5,250	4,180	9,150	13,100	46,600	42,100	13,400	5,760	3,690	2,790	1,600
11	2,560	6,870	4,180	10,100	13,100	48,100	42,100	12,200	5,420	4,070	2,790	1,470
12	2,560	7,840	4,300	10,600	14,200	47,700	41,400	11,900	5.100	4,480	2,790	1,470
13	2,410	6,870	4,430	10,300	15,700	46,600	40,300	11,100	4,780	4,780	2,790	1,470
14	2,410	5,870	4,430	11,600	21,100	44,800	38,100	11,100	4,630	5,260	2,790	1,470
15	2,410	5,250	4,180	14,800	23,800	42,900	36,600	10,800	4,480	5,260	2,790	1,470
16	2,560	4,970	4,180	16,900	24,900	40,700	33,700	10,600	4,480	4,630	2,590	1,350
17	2,560	5,110	4,180	19,400	24,900	39,600	31,900	9,790	4,340	4,070	2,590	1,350
18	2,480	4,700	3,950	21,800	23,800	38,800	30,200	9,060	4,200	3,690	2,500	1,350
19	2,410	4,700	3,720	22,800	22,800	37,700	27,700	8,600	3,820	3,690	2,400	1,350
20	2,340	4,700	3,720	24,900	22,800	37,700	25,300	8,380	3,690	3,450	2,400	1,350
21	2,480	4,700	3,720	24,500	26,700	38,100	23,900	7,940	3,690	3,340	2,400	1,240
22	2,640	5,710	6,520	24,500	30,900	37,700	22,600	7,720	3,450	3,220	2,220	1,240
23	2,260	6,360	4,180	20,100	34,800	37,700	21,300	7,300	3,450	3,220	2,220	1,240
24	2,120	6,520	7,240	17,500	38,400	37,000	20,300	7,100	3,450	3,220	2,220	1,240
25	1,990	5,400	12,900	16,300	41,000	37,000	20,300	7,300	3,220	3,220	2,050	1,240
26	1,820	5,870	13,400	16,000	42.500	36,300	20,300	7,510	3,220	3,220	2,050	1,240
27	2,060	6,030	13.400	15,100	41,800	37,000	20,300	9.300	3,220	3,220	1,890	1,350
28	2,260	7,440	12,900	15,100	42,900	37.300	20,300	8,600	3,220	3,220	1,890	1,350
29	2,480	....	12,100	15,100	40,700	38,400	19,700	8,160	3,220	3,000	1,890	1,350
30	2,560	....	11,100	15,100	37,000	38,400	19,700	7.720	3,220	3,000	1,890	1,350
31	2,720	....	10,100	....	29,800	....	19,000	7,300	....	3,000	....	1,350

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.											
1	....	1,740	4,200	9,060	14,000	14,400	5,730	5,000	6,120	3,220	800
2	....	1,740	3,940	8,600	13.400	13,900	6,510	4,820	5,000	3,220	800
3	....	1,890	3,690	8,160	13,400	12,800	7,540	4,820	4,480	2,950	800
4	....	2,400	3,450	8,160	11,900	12,800	8,220	4,480	4,150	2,950	800
5	....	2,400	3,450	8,380	11,400	12,800	8,890	4,320	3,820	2,950	750
6	....	2,590	3,450	8,830	13,400	12,800	7,780	4,150	3,660	2,700	800
7	....	2,590	3,450	9,060	13,400	13,300	5,540	3,660	3,510	2,700	895
8	....	2,590	3,450	9,300	14,000	13,300	5,000	3,080	3,220	2,470	....
9	....	2,590	3,450	9,540	13,400	12,800	4,820	2,950	3,220	2,470	....
10	....	2,790	3,450	10,300	14,000	12,800	8,000	2,700	2,950	2,260	....
11	....	2,790	3,450	10,800	13,400	12,800	6,710	2,470	2,950	2,260	....
12	....	2,790	3,450	11,700	14,300	12,500	4,820	2,470	2,950	2,260	....
13	....	2,790	3,450	13,700	16,200	12,500	5,360	2.260	2,950	2,260	....
14	....	3,000	3,820	14,300	19,700	12,000	8,000	2,260	2,950	2,260	....
15	....	3,000	4,340	14,600	20,300	11,000	7,340	2,260	2,700	2,070	....
16	....	3,450	5,100	14,000	22,900	10,800	7,340	2,070	2,700	1,980	....
17	....	4,630	5,120	12,200	23,600	10,800	7,560	2,070	2,700	1,900	....
18	....	4,780	5,940	11,700	24,300	10,300	7.560	2,070	3,080	1.750	....
19	....	4,200	6,700	11,100	24,300	9,820	7,130	2,070	3,820	1,750	....
20	....	3,940	7,510	11,100	25,000	9,350	7,130	1,900	4,650	1,600	....
21	....	4,340	8,830	11,700	25,000	8,890	7,560	2,070	4,650	1.460	....
22	....	5,100	10,300	12,500	22,400	8,440	7,560	5,170	4,150	1,460	....
23	1,740	5,940	11,400	13,100	21,800	8,000	7,560	3,820	3,820	1,600	....
24	1.740	5,420	12,500	13,400	22.800	8,000	7,130	3,510	3,510	1,600	....
25	1,740	5,100	12,800	14,300	21,800	7,560	6,920	4,820	3,510	1,900	....
26	1,890	5,100	12,800	12,800	20,800	6,510	6,710	4,150	3,510	1,900	....
27	1,890	4,780	11,900	12,500	19,200	6,120	6,710	3,220	3,510	2,070	....
28	1,740	4,340	11,400	13,700	18,600	5,540	6,510	3,680	3,220	2,070	....
29	1,740	4,070	10,800	14,300	17,100	4,820	6,310	3,820	3,220	1,900	....
30	....	3,940	9.800	14,000	16,200	5,730	5,920	5,300	3,220	830	....
31	....	3,940	....	14,000	....	4,820	5,360	....	3,220	....	....

Daily discharge, in second-feet, of Green River at Greenriver, Utah, for 1905–1909—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	930	2,580	1,600	10,500	12,300	33,400	42,600	12,500	17,400	4,820	3,220	4,820
2	1,100	2,260	1,460	9,580	14,400	34,800	40,800	12,000	18,000	4,820	3,080	3,980
3	1,210	2,260	1,600	8,890	14,700	34,100	40,100	11,000	15,300	4,820	2,950	3,360
4	1,210	1,900	1,750	8,000	14,200	33,000	39,400	10,800	11,800	4,650	3,080	2,950
5	1,210	1,750	2,260	7,780	13,100	32,700	38,300	10,300	11,000	4,480	3,220	2,070
6	1,210	1,750	2,070	7,130	11,000	35,200	37,200	9,820	12,000	4,480	3,220	1,530
7	1,460	1,600	2,360	9,350	11,300	39,400	37,600	9,350	13,900	4,480	3,220	1,270
8	1,600	1,460	2,820	12,800	13,100	42,600	36,600	9,350	12,800	4,150	3,220	1,160
9	1,750	1,460	3,360	13,300	15,600	45,200	36,600	9,580	11,800	4,150	3,220	1,060
10	1,900	1,330	3,820	11,000	19,500	51,100	36,200	9,350	10,800	4,150	3,220	930
11	1,900	1,330	4,150	8,440	21,200	55,900	34,100	8,890	10,800	3,980	3,220	895
12	2,070	1,460	4,480	8,000	22,100	59,600	31,000	8,440	12,000	3,980	3,220	......
13	2,070	1,460	4,150	7,130	25,400	62,200	29,600	8,440	12,800	3,510	3,220	......
14	2,260	1,530	4,480	5,360	24,800	60,400	24,800	8,000	12,300	3,820	3,080	......
15	2,260	1,460	5,000	4,820	26,400	55,600	22,800	8,060	10,800	3,980	2,950	......
16	2,070	1,600	4,480	5,170	24,800	52,200	21,500	11,500	9,580	4,150	2,950	......
17	1,750	1,750	3,980	5,730	24,100	48,200	20,200	14,100	9,120	4,150	2,950	......
18	1,750	1,750	3,510	6,120	23,100	44,800	18,600	13,100	8,660	4,480	2,700	......
19	1,900	1,680	3,980	7,780	22,400	43,700	18,000	12,800	8,000	4,320	2,700	......
20	1,900	1,600	4,320	10,100	23,100	45,200	17,700	12,300	8,000	3,820	2,580	......
21	1,820	1,750	6,920	13,100	23,100	46,300	16,500	11,500	7,560	3,660	2,470	......
22	1,900	1,900	11,300	16,200	24,400	47,800	14,700	12,300	7,130	3,510	2,470	......
23	1,900	2,070	19,200	14,400	26,800	47,400	15,000	11,800	6,710	3,220	2,700	......
24	2,360	1,900	33,000	12,800	27,800	48,500	15,900	10,800	6,310	3,220	2,820	......
25	2,470	1,750	23,800	11,000	29,200	50,400	14,700	9,580	6,310	3,360	2,950	......
26	1,980	1,600	19,900	9,580	30,200	50,000	14,400	9,120	5,920	3,510	2,700	......
27	2,360	1,600	17,700	8,000	32,700	50,000	13,900	8,890	5,920	3,360	2,700	......
28	2,950	1,530	15,900	9,580	32,400	49,600	13,900	8,440	5,540	3,220	2,950	......
29	3,360	....	14,700	9,120	29,600	45,600	13,300	8,000	5,360	3,220	2,950	......
30	3,510	....	12,500	8,000	30,600	44,400	13,300	8,660	5,170	3,220	3,510	......
31	3,220	....	11,300	....	31,300	....	12,800	9,820	....	3,220	....	......

NOTE.—These daily discharges are based on rating curves applicable as follows (except as noted): Feb. 16, 1905, to May 21, 1907, well defined between 2,000 and 37,000 second-feet; May 22, 1907, to June 21, 1908, fairly well defined between 5,000 and 39,000 second-feet; June 22, 1908, to Dec. 31, 1909, well defined between 2,500 and 39,000 second-feet.

Discharge estimated for ice periods as follows: Dec. 21 to 30, 1905, 1,200 second-feet per day; Jan. 1 to 31, 1906, 1,400 second-feet per day; Feb. 1 to 12, 1906, 1,500 second-feet per day; Jan. 1 to 31, 1908, 1,300 second-feet per day; Feb. 1 to 10, 1908, 1,400 second-feet per day; Feb. 11 to 22, 1908, 1,500 second-feet per day; Dec. 8 to 31, 1908, 800 second-feet per day; Dec. 12 to 31, 1909, 800 second-feet per day.

These estimates for ice periods are based on the observers' notes and the climatological data of the United States Weather Bureau.

Monthly discharge of Green River at Greenriver, Utah, for 1905–1909.

[Drainage area, 38,200 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
1905.							
March	3,840	1,760	2,990	0.078	0.09	184,000	A.
April	6,360	2,720	4,070	.106	.12	242,000	A.
May	24,200	6,360	12,900	.338	.39	793,000	A.
June	33,900	14,000	24,300	.636	.71	1,450,000	B.
July	13,400	4,180	7,640	.200	.23	470,000	A.
August	3,840	1,870	2,730	.071	.08	168,000	A.
September	6,030	1,870	2,510	.066	.07	149,000	A.
October	6,190	1,870	2,480	.065	.07	152,000	A.
November	2,560	1,820	2,050	.054	.06	122,000	A.
December	1 870	....	1,320	.035	.04	81,200	C.
The period	....	....	....	....	....	3,810,000	

Monthly discharge of Green River at Greenriver, Utah, for 1905-1909—Continued.

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
1906.							
January			[a]1,400	0.037	0.04	86,100	D.
February			[b]1,620	.042	.04	90,000	C.
March	21,800	1,870	6,110	.160	.18	376,000	B.
April	16,900	5,400	9,580	.251	.28	570,000	A.
May	36,500	12,400	24,800	.649	.75	1,520,000	A.
June	42,100	24,500	31,300	.819	.91	1,860,000	A.
July	15,700	8,040	13,400	.351	.40	824,000	A.
August	8,260	4,430	6,170	.162	.19	379,000	A.
September	7,440	3,720	5,080	.133	.15	302,000	A.
October	3,720	2,560	3,020	.079	.09	186,000	A.
November	5,870	1,760	3,260	.085	.09	194,000	A.
December	3,280	1,700	2,430	.064	.07	149,000	B.
The year	42.100		9,050	.237	3.19	6,540,000	
1907.							
January	2,900	1,820	2,440	.064	.07	150,000	B.
February	7,840	2,560	4,910	.129	.13	273,000	A.
March	13,400	3,720	6,760	.177	.20	416,000	A.
April	24,900	6,030	14,000	.367	.41	833,000	A.
May	42,900	13,100	24.700	.647	.75	1,520,000	B.
June	48,100	29,800	38,800	1.02	1.17	2,310,000	B.
July	42,900	19,000	31,600	.828	.95	1,940,000	B.
August	19,300	7,100	11,200	.293	.34	689,000	A.
September	7,940	3,220	4,820	.126	.14	287,000	A.
October	5,260	3,000	3,670	.096	.11	226,000	A.
November	3,000	1,890	2,560	.067	.07	152,000	B.
December	1,890	1,240	1,470	.038	.04	90,400	C.
The year	48,100	1,240	12,300	.322	4.38	8,890,400	
1908.							
January	1,820	1,350	1,300	.034	.04	79,900	C.
February	1,890	1,600	1,530	.040	.05	88,000	C.
March	5,940	1,740	3,570	.093	.11	220,000	A.
April	12,800	3,450	6,590	.172	.19	392,000	A.
May	14,600	8,160	11,600	.304	.35	713,000	A.
June	25,000	11,400	18,100	.474	.53	1,080,000	A.
July	14,400	4,820	10,300	.270	.31	633,000	A.
August	8,890	4,820	6,810	.179	.21	419,000	A.
September	5,300	1,900	3,380	.088	.10	201,000	B.
October	6.120	2,700	3,580	.094	.11	220,000	B.
November	3,220	830	2,160	.057	.06	129,000	C.
December	1,460	750	801	.021	.02	49,300	
The year	25.000	750	5,810	.152	2.08	4,220,000	
1909.							
January	3,510	930	1,980	.052	.06	122,000	B.
February	2,580	1,330	1.720	.045	.05	95,500	B.
March	33.000	1,460	8,120	.213	.25	499,000	B.
April	16,200	4,820	9,290	.243	.27	553,000	A.
May	32.700	11,000	22,400	.586	.68	1,380,000	A.
June	62.200	32,700	46,300	1.21	1.35	2,760,000	C.
July	42,600	12,800	25,200	.660	.76	1,550,000	A.
August	14,100	8,000	10,300	.270	.31	633,000	A.
September	18,000	5,170	9,960	.261	.29	593,000	A.
October	4,820	3,220	3,930	.103	.12	242,000	A.
November	3,510	2,470	2.980	.078	.09	177,000	A.
December	4,820	[a]800	1,290	.034	.04	79,300	C.
The year	62,400	[a]800	12,000	.314	4.27	8,680,000	

[a] Estimated.

[b] One-half month estimated.

NOTE.—See notes under 1909 daily discharge table for estimates during ice periods, 1905 to 1909.

COLORADO RIVER AT YUMA, ARIZ.

This station, which is located in the town of Yuma, Ariz., 1½ miles below the mouth of Gila River and 10 miles by river above the Mexican border, furnishes information concerning the amount of water available for irrigation along the lower Colorado River. Records of river height have been kept by the Southern Pacific Co. since April 1, 1878.

The records given herewith are furnished by the United States Reclamation Service, through F. L. Sellew, project engineer, Yuma, Ariz.

As the bed of the stream is composed of silt and sand and is very unstable frequent measurements are necessary to properly determine the daily discharge. Neither bank is subject to overflow. Previous to May 31, 1903, discharge measurements were made from the railroad bridge. On that date a cable station was established at a point 600 feet below the bridge, and all measurements are now made from a car, except during highest floods, when a boat is used. At flood stages a large part of the water flows through an old channel and does not pass under the cable. At such times this overflow water is measured at the point where it passes under the railway trestle, one-third mile north of the main channel.

The staff gage is in two sections, the upper section reading above 24 feet being the original gage established in 1876. It is located at the railroad bridge, 600 feet above the cable station. The elevation of the zero of the gage is 137.4 feet above sea level.

Discharge measurements of Colorado River at Yuma, Ariz., in 1909.

[By R. L. North and N. B. Conway.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 1	18.70	7,800	Apr. 1	24.90	43,800
4	18.40	6,000	3	23.40	33,500
6	18.60	6,800	5	22.60	29,100
8	18.30	6,100	8	21.40	24,100
12	18.30	5,800	10	21.20	21,600
15	18.80	6,200	12	21.80	25,600
18	19.40	7,400	15	21.95	26,400
20	19.60	11,900	17	21.50	22,500
22	19.20	9,900	20	21.30	22,000
25	20.40	15,300	22	21.20	21,300
27	20.90	21,300	24	22.65	32,900
30	20.50	17,600	26	24.20	43,700
Feb. 1	21.80	25,100	28	24.65	46,100
3	20.70	18,100	30	23.90	41,900
5	20.10	15,500	May 3	22.70	32,400
9	19.70	12,300	5	23.20	38,600
11	19.70	12,000	7	23.40	40,400
15	19.80	11,400	10	23.00	37,300
17	20.00	11,800	12	23.50	42,500
19	20.30	12,800	14	24.20	49,000
23	20.20	12,200	17	25.20	60,400
25	20.90	16,800	19	25.70	65,400
27	20.00	12,000	21	26.20	68,500
Mar. 1	19.90	11,400	24	25.95	64,700
3	20.20	12,000	26	25.50	65,400
5	20.30	12,900	29	25.80	71,400
8	20.20	11,100	June 1	26.50	74,600
10	20.30	11,600	3	26.90	76,700
13	20.75	15,700	7	27.10	78,700
15	20.90	17,500	9	27.05	79,000
17	21.10	18,700	12	26.45	77,100
19	20.80	16,100	14	26.80	80,400
23	20.80	14,600	16	27.60	90,700
25	21.50	18,200	18	28.80	114,900
27	21.50	17,700	20	29.60	126,000
29	21.50	16,900	22	30.30	139,500

Discharge measurements of Colorado River at Yuma, Ariz., in 1909—Continued.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
June 24	30.75	149,500	Oct. 12	16.30	13,500
26	30.65	145,000	12	16.30	13,300
July 1	29.40	130,200	14	16.30	12,700
3	29.40	132,400	14	16.30	12,900
6	29.00	132,000	16	16.50	13,700
8	28.20	116,900	16	16.50	13,700
10	27.00	102,900	19	16.40	13,100
13[a]	25.50	86,300	19	16.40	13,300
15[a]	24.60	75,300	21	16.40	12,900
17[a]	23.80	68,400	21	16.40	12,900
19[a]	22.20	62,600	23	16.40	12,700
22[a]	20.00	42,900	23	16.40	12,600
24[a]	19.40	35,600	26	16.30	12,000
26[a]	18.90	34,400	26	16.30	12,000
29[a]	19.25	46,500	28	16.30	11,400
31[a]	19.80	51,900	30	16.00	11,100
Aug. 3[a]	19.50	44,300	30	16.00	11,000
5[a]	18.90	38,700	Nov. 1	16.00	10,900
7[a]	18.60	36,100	4	15.90	10,000
10[a]	18.00	28,400	6	15.80	9,600
12[a]	18.40	30,400	9	15.80	9,300
14[a]	18.30	28,500	11	15.80	8,700
17[a]	19.30	42,500	13	15.80	9,100
19[a]	19.80	42,300	16	15.90	9,000
21[a]	19.70	39,400	18	15.90	9,100
24[a]	20.95	53,800	20	15.90	9,400
26[a]	21.20	50,600	23	15.90	9,300
28[a]	20.20	47,200	27	16.00	9,500
31[a]	19.80	42,400	30	15.85	9,000
Sept. 2[a]	19.45	39,000	Dec. 2	15.90	9,600
4[a]	21.10	65,200	4	16.00	9,800
7[a]	20.80	50,400	7	16.10	10,800
11[a]	22.30	76,000	9	16.10	11,600
15[a]	22.50	79,900	11	16.00	10,900
18[a]	19.90	40,000	14	16.00	10,200
21	18.90	33,600	16	15.70	9,300
23	18.40	29,400	18	15.35	7,600
28	17.60	22,600	21	15.10	6,300
30	17.40	21,300	23	15.20	6,600
Oct. 2	17.10	19,200	25	15.30	6,600
5	16.80	17,200	28	15.00	5,700
7	16.70	16,100	30	14.80	4,800
9	16.50	14,500			

[a] Acoustic meter used and the coefficient of reduction was taken as 90 per cent.

Daily gage height, in feet, of Colorado River, at Yuma, Ariz., for 1909.

[R. L. North and N. B. Conway, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.65	21.7	19.9	24.8	23.45	26.6	29.4	20.0	19.5	17.35	16.0	15.8
2	18.6	21.1	20.2	24.1	23.0	26.7	29.45	19.8	19.5	17.1	16.0	15.95
3	18.45	20.6	20.25	23.5	22.7	26.9	29.4	19.4	19.6	17.05	15.9	16.0
4	18.35	20.2	20.55	23.05	22.85	27.0	29.35	19.05	21.25	16.9	15.85	16.05
5	18.55	20.1	20.3	22.65	23.25	27.0	29.15	18.9	21.75	16.8	15.8	16.0
6	18.6	20.05	20.3	22.15	23.45	27.1	29.05	18.85	21.05	16.8	15.8	16.0
7	18.4	19.85	20.35	22.0	23.35	27.15	28.6	18.5	20.9	16.7	15.8	16.1
8	18.25	19.75	20.15	21.55	23.05	27.15	28.1	18.45	20.4	16.6	15.8	16.2
9	18.3	19.7	20.25	21.65	23.0	26.95	27.6	18.3	20.35	16.5	15.8	16.1
10	18.3	19.65	20.35	21.3	23.0	26.65	26.95	18.05	21.65	16.4	15.8	16.0
11	18.35	19.7	20.35	21.75	23.15	26.4	26.55	18.05	22.45	16.3	15.75	16.0
12	18.3	19.7	20.5	21.8	23.55	26.45	26.1	18.35	23.3	16.3	15.75	16.0
13	18.45	19.9	20.75	21.8	23.95	26.6	25.6	18.35	23.7	16.3	15.8	16.0
14	18.7	19.8	20.85	21.95	24.2	26.9	25.05	18.35	23.5	16.35	15.8	16.0
15	18.8	19.9	20.9	22.0	24.5	27.25	24.65	18.85	22.3	16.35	15.8	16.0
16	18.9	20.1	20.9	21.85	24.9	27.6	24.2	20.4	21.2	16.5	15.9	15.7
17	19.05	20.05	21.05	21.45	25.3	28.25	23.65	19.35	20.35	16.45	15.95	15.5
18	19.6	20.5	20.85	21.25	25.6	28.8	22.8	19.1	19.85	16.4	15.9	15.3
19	19.75	20.35	20.8	21.35	25.8	29.3	22.05	19.85	19.55	16.45	15.9	15.25
20	19.6	20.3	20.85	21.35	26.2	29.7	21.35	19.95	19.2	16.4	15.9	15.2

Daily gage height, in feet, of Colorado River, at Yuma, Ariz., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	19.35	20.15	20.65	21.25	26.2	30.05	20.7	19.8	18.85	16.4	15.95	15.15
22	19.2	20.2	20.65	21.25	26.3	30.25	20.05	20.65	18.6	16.4	15.9	15.2
23	19.1	20.3	21.0	21.55	26.2	30.5	19.8	20.45	18.35	16.4	15.9	15.25
24	19.25	20.45	21.3	22.8	25.95	30.75	19.45	21.0	18.2	16.3	15.95	15.3
25	20.4	20.75	21.55	23.7	25.75	30.75	19.1	21.1	18.05	16.3	16.05	15.3
26	20.35	20.25	21.6	24.3	25.5	30.65	18.9	21.15	17.8	16.3	16.0	15.3
27	20.85	20.0	21.5	24.65	25.55	30.45	19.1	20.5	17.7	16.3	16.0	15.15
28	20.55	19.9	21.5	24.65	25.75	30.1	18.95	20.1	17.6	16.25	15.95	15.0
29	20.55	....	21.55	24.15	25.85	29.85	19.35	19.35	17.55	16.1	15.95	14.9
30	20.5	....	22.15	23.85	26.0	29.65	19.75	19.45	17.4	16.0	15.85	14.75
31	22.0	....	24.3	....	26.35	....	19.85	19.9	....	16.0	....	14.6

Daily discharge, in second-feet, of Colorado River at Yuma, Ariz., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7,800	25,100	11,400	43,800	39,400	75,100	130,200	51,600	39,800	20,700	10,900	8,800
2	7,100	21,100	13,200	37,600	36,900	75,600	133,000	48,500	39,300	19,200	10,900	9,800
3	6,100	18,100	12,000	33,500	32,400	76,700	132,400	43,300	47,800	18,800	10,100	9,900
4	6,000	14,900	12,700	31,100	33,600	77,200	133,700	39,200	66,200	17,800	9,800	10,100
5	6,900	15,500	12,900	29,400	39,200	77,200	132,300	38,700	65,700	17,200	9,600	9,900
6	6,800	15,300	12,900	26,600	41,700	78,700	133,000	39,500	56,200	17,000	9,600	10,000
7	6,000	14,400	13,400	25,800	40,000	79,200	124,700	33,000	51,000	16,100	9,500	10,800
8	6,100	14,000	11,100	24,700	37,200	79,200	115,400	34,200	52,000	15,300	9,400	11,900
9	6,100	12,300	12.000	25,100	36,800	78,700	110,000	32,300	55,200	14.500	9,300	11,600
10	6,100	11,900	11,600	22,800	37,400	77,700	102,000	29,300	67,300	13,900	9,000	10,900
11	6,200	12,000	11,800	28,500	38,500	76,900	98,500	25,000	77,500	13,600	8,300	10,900
12	5,800	12,000	12,600	25,600	43,000	77,100	93,500	29,500	87,700	13,500	8,300	10,700
13	5,900	13,800	15,700	25,600	47,200	78,500	88.100	29,600	93,200	13,100	9,100	10,400
14	6,100	11,400	16,600	26,600	49,000	81,300	80,800	29,600	91,500	13,100	8,800	10,200
15	6,200	11,400	17,500	26,700	51,800	86,200	76,200	34,900	77,800	12,800	8,400	9,900
16	6,300	12,000	17,500	25,900	55,500	90,700	71,700	47,400	63,700	13,700	9,000	9,300
17	6,400	11,800	18,700	22,100	61,500	103.700	66,300	42,800	50,700	13,300	9,700	8,400
18	7,400	13,500	17,200	20,300	65,000	114,900	62,700	39,500	39,600	13,000	9,100	7,300
19	8,100	12,800	16,100	21,200	66,400	124,900	60,200	42.700	37,800	13,600	9,200	7,000
20	11,900	12,800	16,500	22,100	70,400	127,500	54,500	42,300	35,500	13,200	9,400	6,800
21	10,600	12,300	14,800	21,900	68,500	134,500	48,700	40,200	33,300	12,900	9,900	6,500
22	9,900	12,500	14,800	21,600	69,100	138,700	43,500	47,700	31,100	12,800	9,400	6,700
23	9.400	12,200	14,600	23,800	68.500	144,200	40,300	48,500	28,000	12,700	9,300	6,800
24	10,200	13,700	17,200	34,100	64,700	149,500	36,000	54,100	27.700	12,200	9,600	6,800
25	15,300	16,800	18,200	41,300	61,700	148,000	34,500	52,400	26,500	12,100	10,500	6,600
26	15,100	12,500	18,700	44.400	65,400	145,000	34,400	50.200	24,400	12,000	9,800	6,800
27	21,300	12,000	17,700	46,800	66,400	142,700	39.200	47,600	23.600	11,700	9,500	6,200
28	17,100	11,500	17,700	46,100	70.400	138,300	40,700	46,500	22,600	11,200	9,400	5,700
29	17,100	....	16,900	43,400	72,400	135,200	47,700	40,800	22,300	11,000	9,500	5,300
30	17,600	....	21,700	41,600	72,300	133,100	51,800	40,800	21,300	11,000	9,000	4,600
31	31,500	....	35,900	....	73,900	....	52,800	43,100	....	11,000	....	4,100

NOTE.—These discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Colorado River at Yuma, Ariz., for 1909.

[Drainage area, 225,000 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	31,500	5,800	10,000	0.044	0.05	615,000
February	25,100	11,400	13,900	.062	.06	772,000
March	35,900	11,100	15,900	.071	.08	978,000
April	46,800	20,300	30,300	.135	.15	1,800,000
May	73.900	32,400	54,100	.240	.28	3,330,000
June	149,500	75,100	105,000	.467	.52	6,250,000
July	133,700	34,400	79,600	.354	.41	4,890,000
August	54,100	25,000	40,800	.181	.21	2,510,000
September	93,200	21,300	48,500	.216	.24	2,890,000
October	20,700	11,000	14,000	.062	.07	861,000
November	10,900	8,300	9,440	.042	.05	562,000
December	11,900	4,100	8,410	.037	.04	517,000
The year	149,500	4,100	35,800	.159	2.16	26,000,000

SALTON SINK.

SALTON SEA NEAR SALTON, CAL.

Salton Sink originally formed a part of the Colorado Desert, which extends northwestward almost 100 miles from the California-Mexico boundary line and comprises an area of nearly 2,000 square miles. This desert comprises two fertile valleys, one to the northwest of the sink, in Riverside County, known as the Coachella Valley, and the other to the southeast of the sink, in Imperial County, called the Imperial Valley. Salton Sea, which now partly fills the sink, lies between the two valleys, being partly in Riverside County and partly in Imperial County. It is about 160 miles southeast of Los Angeles, 90 miles northwest of Yuma, and 50 miles north of Calexico. The longer diameter of the sea trends northwest and southeast. On December 31, 1908, its surface was 206 feet below mean sea level, its length was nearly 45 miles, its maximum width about 15 miles, its minimum width 9.5 miles, its maximum depth 67.5 feet, and its superficial area about 443 square miles.

During the high water of the summer of 1891 the Colorado overflowed into Salton Sink to such an extent as to endanger the Southern Pacific Railroad at its lowest point. In the summer of 1905, after a succession of winter and spring floods in Gila River followed by an exceptionally heavy summer flow in the Colorado, the flood into the sink was repeated on a much larger scale. The old river channel occupied by Alamo River was transformed into a deep wide gorge, and another channel, now called New River, was formed. The flood did great damage to the tracks of the Southern Pacific Railroad, to the plant of the New Liverpool Salt Co. below Mecca, and to the ranches in the vicinity.

Gage-height records kept by the New Liverpool Salt Co. from November, 1904, to February 26, 1906, show the actual depth of the water above the lowest portion of the sink. February 23, 1906, the Government installed a gage at the same datum, about half a mile west of Salton railroad station and 3 miles southeast of the old Salton station. This gage was destroyed by waves. The Southern Pacific Co. had graduated a trestle bent across Salt Creek about 2½ miles east of Salton, using the company's datum; the zero of this gage is 273.5 feet below mean sea level as determined from United States Geological Survey bench marks, or at an elevation of 280.3 feet below sea level according to the Southern Pacific Co.

Practically all the water received by Salton Sea enters through Alamo and New rivers, but chiefly through the former. These rivers run through Imperial Valley and are the drainage channels for the excess and waste water from the irrigation system and from the power plants.

The following tables show the fluctuation of the surface of Salton Sea:

Daily gage height, in feet, of Salton Sea near Salton, Cal., for 1909.

[J. A. Jeffreys and Benj. C. Kedel, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	67.45	67.4	67.25	67.0	66.7	66.25	65.9	65.3	65.35	64.7	64.1	63.65
2	67.45	67.4	67.25	67.0	66.7	66.25	65.95	65.25	65.3	64.65	64.1	63.65
3	67.45	67.4	67.25	67.0	66.7	66.25	65.85	65.2	65.25	64.6	64.1	63.65
4	67.45	67.4	67.25	67.0	66.7	66.2	65.8	65.2	65.3	64.6	64.05	63.65
5	67.45	67.4	67.2	66.95	66.7	66.2	65.8	65.2	65.25	64.55	64.05	63.6
6	67.45	67.4	67.2	66.95	66.7	66.15	65.75	65.15	65.25	64.55	64.05	63.6
7	67.4	67.35	67.2	66.95	66.7	66.1	65.75	65.35	65.3	64.5	64.05	63.55
8	67.4	67.35	67.2	66.95	66.7	66.1	65.75	65.3	65.25	64.5	64.0	63.55
9	67.4	67.35	67.2	66.95	66.65	66.15	65.7	65.3	65.25	64.5	64.0	63.6
10	67.4	67.3	67.15	66.95	66.65	66.15	65.7	65.25	65.25	64.45	63.95	63.55
11	67.45	67.3	67.15	66.9	66.65	66.15	65.7	65.25	65.2	64.45	63.95	63.55
12	67.45	67.3	67.15	66.9	66.65	66.15	65.7	65.25	65.15	64.45	63.9	63.55
13	67.45	67.3	67.1	66.9	66.65	66.15	65.65	65.2	65.1	64.4	63.9	63.55
14	67.45	67.3	67.1	66.9	66.65	66.1	65.65	65.2	65.05	64.4	63.9	63.55
15	67.45	67.3	67.1	66.9	66.65	66.1	65.65	65.2	65.05	64.4	63.85	63.55
16	67.45	67.3	67.1	66.9	66.6	66.1	65.65	65.25	65.05	64.35	63.8	63.5
17	67.45	67.3	67.1	66.9	66.6	66.05	65.6	65.15	65.0	64.35	63.8	63.5
18	67.45	67.3	67.1	66.85	66.6	66.05	65.55	65.2	65.0	64.3	63.75	63.5
19	67.45	67.3	67.05	66.85	66.6	66.0	65.55	65.2	65.0	64.3	63.75	63.5
20	67.45	67.3	67.05	66.85	66.6	66.0	65.55	65.15	64.95	64.3	63.75	63.5
21	67.45	67.3	67.05	66.8	66.6	66.0	65.55	65.2	64.9	64.3	63.75	63.45
22	67.4	67.3	67.05	66.8	66.6	66.0	65.55	65.15	64.9	64.25	63.7	63.45
23	67.4	67.3	67.05	66.8	66.55	66.0	65.55	65.15	64.9	64.25	63.7	63.45
24	67.4	67.3	67.05	66.8	66.55	65.95	65.5	65.15	64.9	64.25	63.75	63.45
25	67.4	67.3	67.05	66.8	66.5	65.95	65.45	65.15	64.85	64.25	63.75	63.4
26	67.4	67.25	67.05	66.75	66.45	65.95	65.45	65.1	64.85	64.2	63.75	63.4
27	67.4	67.25	67.05	66.75	66.45	65.95	65.4	65.1	64.8	64.2	63.7	63.4
28	67.4	67.25	67.05	66.75	66.4	65.95	65.35	65.1	64.8	64.2	63.7	63.4
29	67.4	......	67.05	66.75	66.35	65.9	65.35	65.1	64.75	64.2	63.7	63.4
30	67.4	......	67.0	66.7	66.3	65.9	65.35	65.15	64.75	64.2	63.65	63.4
31	67.4	......	67.0	......	66.3	......	65.3	65.25	......	64.2	......	63.4

Monthly rise of Salton Sea near Salton, Cal., for 1904–1909.

Month.	Monthly rise.	Total rise.
1904.		
	Feet.	*Feet.*
November	0.6	......
December	.2	0.8
1905.		
January	1.4	2.2
February	1.6	3.8
March	.8	4.6
April	1.2	5.8
May	1.0	6.8
June	2.2	9.0
July	4.4	13.4
August	2.2	15.6
September	1.2	16.8
October	1.4	18.2
November	1.6	19.8
December	2.9	22.7
1906.		
January	1.1	23.8
February	1.8	25.6
March	2.7	28.3
April	5.6	33.9
May	8.7	42.5
June	15.4	57.9
1906.		
	Feet.	*Feet.*
July	8.6	66.5
August	2.9	69.4
September	.9	70.3
October	1.2	71.5
November	− .2	71.3
December	1.2	72.5
1907.		
January	2.8	75.3
February	.7	76.0
March	− .1	75.9
April	− .3	75.6
May	− .5	75.1
June	− .4	74.7
July	− .2	74.5
August	− .3	74.2
September	− .7	73.5
October	− .4	73.1
November	− .5	72.6
December	− .3	72.3
1908.		
January	.0	72.3
February	− .1	72.2
1908.		
	Feet.	*Feet.*
March	−0.2	72.0
April	− .4	71.6
May	− .6	71.0
June	− .5	70.5
July	− .5	70.0
August	− .6	69.4
September	− .8	68.6
October	− .7	67.9
November	− .3	67.6
December	− .2	67.4
1909.		
January	.0	67.4
February	− .15	67.25
March	− .25	67.0
April	− .3	66.7
May	− .4	66.3
June	− .4	65.9
July	− .6	65.3
August	− .05	65.25
September	− .5	64.75
October	− .55	64.2
November	− .55	63.65
December	− .25	63.4

ALAMO RIVER NEAR BRAWLEY, CAL.

During 1908 discharge measurements were made on Alamo River at a highway bridge 3½ miles east of Brawley, Cal., by H. R. Edwards, engineer for the New Liverpool Salt Co.[1] During 1909 measurements were made by engineers of the United States Geological Survey. On June 24, 1909, a continuous record of gage heights was commenced at this point. The staff gage is spiked vertically to a pile in the left abutment of the bridge. The datum of the gage has remained the same during the maintenance of the station. All discharge measurements are made from the bridge.

The data obtained at this station, together with those obtained on New River, show the amount of waste water reaching Salton Sea and are of value in connection with experiments being made by the United States Weather Bureau for determining the evaporation from Salton Sea.

Conditions for obtaining accurate discharge data are poor. The channel is constantly scouring or filling as the stage fluctuates. Both banks are high and well above overflow.

Discharge measurements of Alamo River near Brawley, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 14	Hardy and Jones	55	91	5.01	213
June 24	W. F. Martin	55	128	5.40	401
July 30	.....do	56	120	5.26	290
Sept. 12	A. H. Koebig, jr.	60	175	6.00	675
Dec. 31	.....do	55	82	4.70	164

Daily gage height, in feet, of Alamo River near Brawley, Cal., for 1909.

[Mrs. Flora Helmar, observer.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	5.95	5.5	8.0	5.8	5.4	5.65	16	......	4.7	5.95	5.4	5.0	5.4	5.85
2	......	5.8	5.45	7.6	5.75	5.35	5.45	17	......	4.8	7.65	5.2	5.05	5.35	5.55
3	......	5.9	5.3	7.1	5.65	5.45	5.4	18	......	4.95	7.65	5.15	5.15	5.35	5.45
4	......	5.85	5.35	6.8	5.45	5.45	5.4	19	......	5.05	8.3	5.0	5.2	5.5	5.35
5	......	5.9	5.2	6.3	5.75	5.3	5.45	20	......	4.85	8.1	5.25	5.2	5.65	5.2
6	......	5.7	5.3	4.95	5.55	5.3	5.45	21	......	4.8	7.9	5.7	5.25	5.45	5.15
7	......	5.5	5.3	5.1	5.6	5.25	5.4	22	......	4.95	8.4	5.6	5.25	5.6	5.3
8	......	5.4	5.35	5.55	5.65	5.35	5.4	23	......	4.75	8.35	5.35	5.2	5.35	5.2
9	......	5.35	5.4	6.3	5.65	5.15	5.5	24	5.5	4.65	8.4	5.4	5.2	5.3	5.25
10	......	5.4	5.35	6.2	5.35	5.2	5.8	25	5.65	5.45	8.4	5.45	5.15	5.4	5.55
11	......	5.65	5.15	6.0	5.25	5.25	5.8	26	5.8	5.45	8.5	5.55	5.15	5.55	5.55
12	......	5.6	5.0	6.0	5.25	5.2	6.1	27	5.65	4.9	8.4	5.65	5.2	5.6	5.65
13	......	5.45	5.05	6.4	5.2	5.25	6.1	28	5.9	4.85	7.8	5.8	5.1	5.75	5.35
14	......	5.15	5.3	5.85	5.1	5.35	5.8	29	5.95	4.95	5.95	5.85	5.2	5.8	5.0
15	......	4.8	5.45	5.8	5.05	5.35	5.8	30	5.95	5.2	5.95	6.2	5.3	5.8	4.85
								31	......	5.3	7.15	......	5.3	......	4.55

---

[1] These measurements were published in Water-Supply Paper 249, p. 52.

Daily discharge, in second-feet, of Alamo River near Brawley, Cal., for 1909.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	604	410	1,480	539	368	474	16	......	176	604	368	237	368	560
2	......	539	389	1,310	518	348	389	17	......	194	1,330	293	250	348	432
3	......	582	328	1,100	474	389	368	18	......	226	1,330	278	278	348	389
4	......	560	348	969	389	389	368	19	......	250	1,610	237	293	410	348
5	......	582	293	754	518	328	389	20	......	204	1,530	310	293	474	293
6	......	496	328	226	432	328	389	21	......	194	1,440	496	310	389	278
7	......	410	328	263	453	310	368	22	......	226	1,660	453	310	453	328
8	......	368	348	432	474	348	368	23	......	185	1,640	348	293	348	293
9	......	348	368	754	474	278	410	24	410	168	1,660	368	293	328	310
10	......	368	348	711	348	293	539	25	474	389	1,660	389	278	368	432
11	......	474	278	625	310	310	539	26	539	389	1,700	432	278	432	432
12	......	453	237	625	310	293	668	27	474	214	1,660	474	293	453	474
13	......	389	250	797	293	310	668	28	582	204	1,400	539	263	518	348
14	......	278	328	560	263	348	539	29	604	226	604	560	293	539	237
15	......	194	389	539	250	348	539	30	604	293	604	711	328	539	204
								31	......	328	1,120	......	328	......	153

NOTE.—These discharges are based on a rating curve that is fairly well defined between discharges of 100 and 1,050 second-feet.

Monthly discharge of Alamo River near Brawley, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
June 24-30	604	410	529	7,340	B.
July	604	168	339	20,800	B.
August	1,700	237	856	52,600	B.
September	1,480	226	580	34,500	B.
October	539	237	344	21,200	B.
November	539	278	377	22,400	B.
December	668	153	404	24,800	B.
The period	....	....	....	184,000	

NEW RIVER NEAR BRAWLEY, CAL.

During 1908 discharge measurements were made at a wagon bridge over New River, 1½ miles west of Brawley, Cal., by H. R. Edwards, engineer for the New Liverpool Salt Co.[1] During 1909 measurements were made by engineers of the United States Geological Survey. On June 24, 1909, a continuous record of gage heights was begun at this point. The staff gage is spiked vertically to the third bridge pile from the right bank. The datum of the gage has remained the same during the maintenance of the station. At high stages discharge measurements are made from the bridge, but at medium and low stages measurements are made by wading near the bridge.

The data obtained at this station, together with those obtained on Alamo River, show the amount of waste water reaching Salton Sea and are of value in connection with experiments being made by the United States Weather Bureau to determine the evaporation from Salton Sea.

---

[1] These measurements were published in Water-Supply Paper 249, p. 52.

Conditions for obtaining accurate discharge data are exceedingly poor. The great amount of fine silt carried by this stream causes continual changes in the channel. The current is light at low stages. Floods occur at long intervals and are extremely torrential.

Conditions at this station during 1909 were fairly good up to the middle of August, when heavy rains fell in the Imperial Valley and surrounding country. A considerable flood occurred on New River, washing out the earth approaches to the bridge, and changing the channel so completely that measurements made prior to August are not comparable with those that will be made later. Probably the channel was fairly stable after October 1, 1909, but sufficient discharge measurements have not been made to define the new rating curve. Estimates of flow are, therefore, withheld.

Discharge measurements of New River near Brawley, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 8	Hardy and Jones	23	33	......	46
Jan. 14	H. A. Jones	25.1	32	6.00	47
June 24	W. F. Martin	58	66	6.31	89
July 30	do	48.9	53	6.18	63

NOTE.—All measurements were made from downstream side of wagon bridge.

Mean daily gage height, in feet, of New River near Brawley, Cal., for 1909.

[Herschell Darnell, observer.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	6.15	6.2	6.8	5.0	4.9	4.8	16	......	6.2	6.85	5.0	4.7	4.9	4.8
2	......	6.1	6.2	6.15	4.9	4.85	4.9	17	......	6.25	6.8	5.0	4.7	4.9	4.8
3	......	6.1	6.25	5.5	4.95	4.85	4.8	18	......	6.25	6.8	5.0	4.7	4.9	4.95
4	......	6.15	6.25	5.5	4.8	4.9	4.85	19	......	6.0	7.1	5.0	4.7	4.85	4.85
5	......	6.1	6.25	5.5	4.8	4.9	4.9	20	......	5.9	7.05	5.0	4.7	4.9	4.9
6	......	6.1	5.9	5.6	4.8	4.9	4.85	21	......	5.9	6.75	5.0	4.7	4.9	5.15
7	......	6.1	5.9	5.6	4.8	4.9	4.8	22	......	5.85	6.6	5.0	4.7	4.9	5.0
8	......	6.15	5.9	5.3	4.8	4.85	4.9	23	......	5.8	6.6	5.0	4.7	4.9	5.0
9	......	6.2	5.9	5.3	4.8	4.8	4.9	24	6.3	5.8	6.3	5.0	4.7	4.85	4.9
10	......	6.2	5.9	5.3	4.7	4.8	4.9	25	6.3	6.0	5.95	4.95	4.7	4.9	5.0
11	......	6.2	5.9	5.2	4.7	4.8	4.9	26	6.3	6.05	......	5.0	4.7	4.9	4.9
12	......	6.2	6.2	5.1	4.7	4.8	4.8	27	6.25	6.1	......	4.95	4.7	4.8	4.9
13	......	6.2	7.15	5.0	4.7	4.8	4.8	28	6.3	6.15	......	5.05	4.7	4.9	5.0
14	......	6.2	7.0	5.1	4.7	4.8	4.8	29	6.25	6.2	......	5.0	4.65	4.9	5.0
15	......	6.2	6.9	5.0	4.7	4.9	4.8	30	6.2	6.2	[a]9.2	4.9	4.5	4.8	5.1
								31	......	6.2	8.75	......	4.5	......	5.1

[a] Estimated. Maximum gage height was 12.5 feet.

TRIBUTARY BASINS.

DUCHESNE RIVER BASIN.

DESCRIPTION.

Duchesne River rises in the high peaks of the Uinta and Wasatch mountains in northeastern Utah, flows for about 100 miles in a general southeasterly direction, and enters Green River at Ouray, Utah, about 3 miles above the mouth of White River. The stream has a total drainage area of 4,000 square miles. Altitudes range from 4,700 feet at the mouth of the river to more than 13,000 feet at the summits of the highest peaks.

The principal tributaries of the Duchesne are Rock (East) Creek, Strawberry River, Lake Fork, and Uinta River.

The drainage basin of the upper Duchesne proper is mountainous. The stream emerges from the mountains at the mouth of Rock Creek, at an elevation of about 6,000 feet. From the mouth of Strawberry River down to Lake Fork the valley of the Duchesne is about 2 miles in average width, and is bordered by sandstone bluffs approximately 200 feet high. The bluffs on the northern side of the river are capped by heavy deposits of coarse gravel and cobblestones. The general course of the stream throughout this stretch and on down to the mouth of the Uinta is easterly. Along the lower course of the stream the plateaus on each side of the stream valley are comparatively low and can be easily reached by irrigation canals from the main stream.

Strawberry River, the main upper tributary of the Duchesne, drains an area of about 1,200 square miles. The stream rises in the Uinta Mountains, and enters the Duchesne at Theodore. Its flow is derived chiefly from melting snow, except during the late summer, when the flow comes from small springs well distributed over the entire drainage basin. The upper stream basin has numerous tributaries, particularly from the north and west. Among the most important may be mentioned Indian Creek, Bryant's Fork, Mud Creek, Horse Creek, Sugar Springs, and Co-op Creek. They are all short and fall rapidly until they reach Strawberry Valley, through which they flow sluggishly in well-defined channels. The main stream traverses the valley from north to south and is very sluggish. Indian Creek drains a small portion of the southern slopes of the Uinta Mountains. Its basin comprises smooth, rolling hills, fairly well timbered with pine and aspen. The normal flow is derived chiefly from springs. The greater part of the precipitation is in the form of snow, which covers the ground for six or eight months of each year. As its average elevation is 7,500 feet above sea level, Strawberry Valley is not well suited for agricultural development, but is excellently adapted to grazing. At the mouth of the river, about 35 miles below Strawberry Valley, the elevation is about 5,500 feet, and the fall in that distance is, therefore, nearly 2,000 feet.

Rock Creek, Lake Fork, the Uinta, and its most important tributary, the Whiterocks, head in a series of small lakes in the Uinta Mountains. These lakes are fed by snow that exists the year round in the canyons and on the high slopes. All these streams drain areas mountainous and difficult of access in their upper portions, and all of them emerge from their canyons at an elevation of about 7,000 feet. Rock Creek continues its course in a narrow valley, but the others spread out so that their valleys are comparatively wide, and the adjoining benches relatively low.

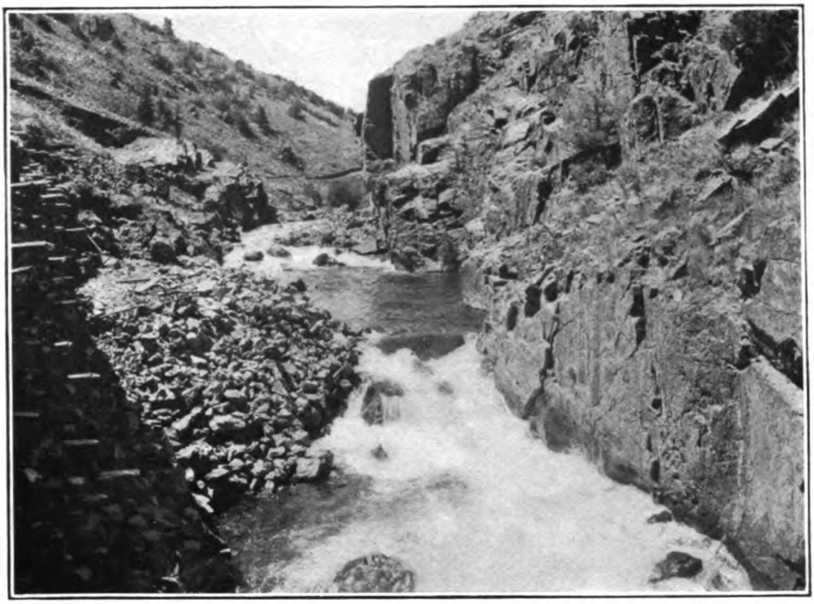
The drainage area of the Duchesne includes about 1,400 square miles of forest reserve, of which about 1,000 square miles may be classed as timbered land with an average stand of over 3,000 feet b. m. to the acre. The principal species of timber are Engelmann spruce and lodgepole pine. The timbered land is distributed through the areas of the various tributaries about as follows: Upper Duchesne, 120 square miles; Rock Creek, 130 square miles; Strawberry River, 380 square miles; Lake Fork, 190 square miles; Uinta (above Whiterocks), 120 square miles; Whiterocks, 70 square miles.

Little information is available as to the precipitation in this basin. In the plains portion of the area the average rainfall is probably less than 10 inches; in the middle portion, comprising considerably over half the area, it probably averages between 10 and 15 inches; in only a small part in the high mountains is there an annual precipitation in excess of 20 inches, and at Fort Duchesne, at an elevation of 5,000 feet, a record extending over several years shows a mean annual rainfall of only 7 inches.

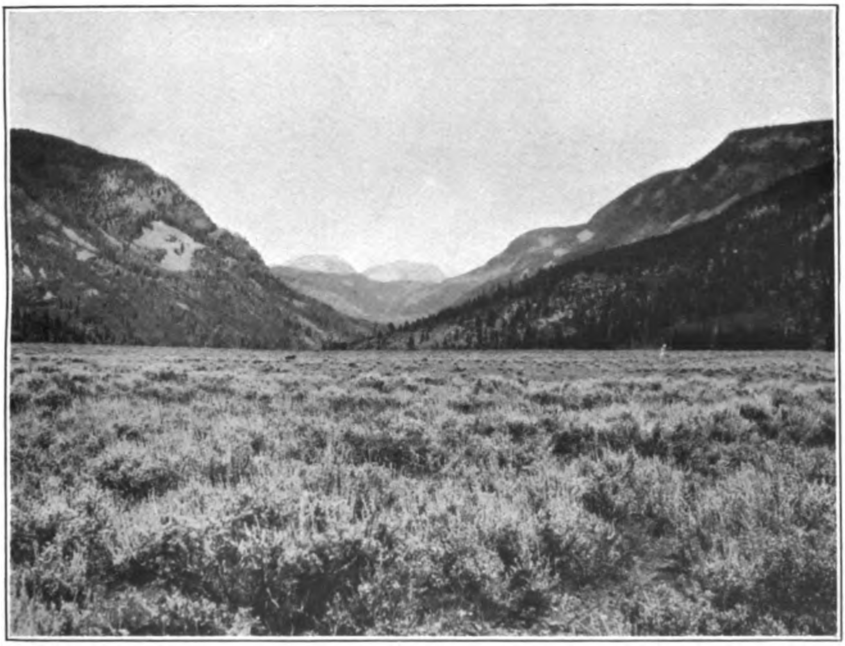
The winters are very severe throughout this basin. In the high mountains the snowfall is heavy, and in many places the snow lies through the whole year. In the hills above an elevation of 7,000 feet there is very considerable snowfall, which usually forms in drifts in canyons, and not infrequently the snow lies for extended periods in the valleys and plateaus of the more open country. All the streams in this region are usually covered with thick ice from about December 1 to April 1 of each year.

At the present time the water in these streams is unused except for irrigation. The United States Indian Service has constructed a series of canals diverting water for irrigation from Lake Fork, the Uinta, and Whiterocks, and the Duchesne proper. The private canal systems now in operation are small, but eventually several hundred thousand acres of land below an elevation of 6,500 feet will be brought under irrigation. Practically no storage is used in connection with any of the irrigation systems now in operation or under construction. As the mountain drainage areas of all the main tributaries are studded with lakes, reservoir sites can easily be found where water can be stored for the irrigation of the valley lands (Pl. IV, *B*). It is believed that the entire flow from the drainage basin can be equalized by storage.

The United States Reclamation Service is constructing a tunnel, with a capacity of 500 second-feet, which will divert water from a



A. DAM SITE FOR RESERVOIR ON WILLIAMS FORK, GRAND RIVER, COLO.



B. RESERVOIR SITE ON WEST FORK OF LAKE FORK ABOVE FORKS, UTAH.

100,000-acre reservoir on the upper Strawberry across the divide to the headwaters of the Spanish Fork, there to be used for irrigation.

At the present time there are no water-power plants in this drainage basin, though with proper storage 200,000 horsepower could be developed. Very little water will be diverted for irrigation above an elevation of 6,500 feet, and as most of the reservoir sites are at an elevation of 8,000 feet or more, good opportunities for power development exist above irrigation diversions. Some of the streams have falls of 100 to 150 feet or more to the mile along these stretches.

None of the records of stream flow in this basin extend back of 1899, and they are not continuous since that time. The driest year for which records are available was 1900, although 1902 was almost as low. The year of greatest average run-off was 1907.

DUCHESNE RIVER AT MYTON,[1] UTAH.

This station, which is located at the highway bridge at Myton, Utah, about 3 miles below the mouth of Lake Fork and about 15 miles above the mouth of the Uinta River, was established October 26, 1899, to determine the amount of water available for storage and irrigation. The records show practically the entire run-off of the Duchesne Basin above the mouth of Uinta River.

Ditches built by the United States Indian Office divert water from this stream and its tributaries for irrigation on the Uinta Reservation. Water is also diverted by private enterprise for irrigation outside the limits of the reservation.

Results at this station are affected by ice for about four months each year, and during this period it is usually impossible to apply open-channel ratings. The discharge has also been more or less affected by eddies about the wooden crib piers and by drift lodged against them.

The datum of the gage remained practically constant from the establishment of the station until June 6, 1909, when the river cut a new channel around the bridge and the bridge station was abandoned. A new chain gage was established July 9, 1909, about one-fourth of a mile upstream from the bridge and at a different datum. This gage was replaced on August 9, 1909, by another chain gage, 100 feet upstream on right bank, at the same datum.

There was no bridge or cable from which discharge measurements could be made during the latter part of 1909.

---

[1] Described in the earlier reports as the Price Road Bridge station.

Discharge measurements of Duchesne River at Myton, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 5 [a]	R. H. Fletcher	100	274	6.44	460
19 [a]	....do	114	313	6.62	574
Feb. 15 [a]	....do	105	265	6.72	483
25 [a]	....do	105	267	6.61	396
Mar. 15 [a]	....do	100	276	6.62	462
29	....do	100	598	5.78	664
Apr. 14	....do	100	583	5.69	558
27	....do	102	639	6.68	1,240
May 12	....do	108	847	8.44	3,340
26	....do	108	872	8.50	3,380
Dec. 22 [b]	....do	110	362	6.00	630

[a] Made through ice.
[b] Made through ice. Gage height refers to different datum.

NOTE.—On Jan. 5 ice was 1.6 feet thick under gage; Jan. 19 it was 1.8 feet thick; Feb. 25, 2 feet thick; Mar. 15, 2.8 feet thick; Mar. 29, ice on edges and floating. Dec. 22, about 1 foot thick, with slush and anchor ice.

Daily gage height, in feet, of Duchesne River at Myton, Utah, for 1909.

[Alice Todd, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.75	6.65	8.55	....	6.3	7.15	5.4	5.3	5.15
2	5.85	6.50	8.8	....	6.2	7.0	5.4	5.3	5.15
3	6.05	6.65	9.3	....	6.1	6.4	5.4	5.3	5.15
4	6.25	6.8	9.8	....	6.0	6.2	5.5	5.3	5.15
5	6.0	7.1	10.1	....	5.9	6.2	5.5	5.3	5.15
6	5.8	7.45	10.35	....	5.9	6.3	5.5	5.3	5.15
7	5.8	7.55	....	....	5.9	6.4	5.4	5.3	5.15
8	5.7	7.7	....	....	5.9	6.4	5.4	5.3	....
9	5.65	7.95	....	....	5.9	6.15	5.4	5.3	....
10	5.7	8.15	....	7.15	5.85	6.1	5.4	5.3	....
11	5.7	8.3	....	7.0	5.85	6.1	5.45	5.3	....
12	5.7	8.4	....	6.9	5.8	6.1	5.4	5.3	....
13	5.65	8.35	....	6.8	5.8	6.0	5.4	5.3	....
14	5.75	8.1	....	6.7	5.8	5.9	5.4	5.3	....
15	5.8	8.0	....	6.6	5.8	5.9	5.4	5.2	....
16	5.9	8.1	....	6.6	5.8	5.8	5.4	5.2	....
17	6.05	8.1	....	6.5	5.8	5.7	5.4	5.15	....
18	6.25	8.0	....	6.5	5.85	5.65	5.4	5.1	....
19	6.3	8.0	....	6.5	5.9	5.65	5.4	5.1	....
20	6.45	8.2	....	6.6	6.05	5.6	5.4	5.25	....
21	6.4	8.4	....	6.55	6.1	5.6	5.35	5.3	....
22	6.3	8.7	....	6.4	6.2	5.6	5.35	5.3	....
23	6.3	8.8	....	6.4	6.25	5.55	5.35	5.3	....
24	6.25	8.8	....	6.45	6.1	5.55	5.35	5.3	....
25	6.35	8.7	....	6.4	6.0	5.55	5.35	5.25	....
26	6.4	8.6	....	6.45	5.9	5.5	5.35	5.2	....
27	6.7	8.6	....	6.6	5.85	5.5	5.35	5.2	....
28	6.9	8.8	....	6.7	5.8	5.5	5.35	5.15	....
29	7.0	9.0	....	6.6	5.7	5.5	5.35	5.15	....
30	6.8	8.85	....	6.5	5.7	5.45	5.3	5.15	....
31	....	8.6	....	6.45	6.05	....	5.3	....	....

NOTE.—Ice conditions during January, February, March, and from about Dec. 8 to 31; gage washed out June 6. New gage referred to new datum, installed on July 10.

Daily discharge, in second-feet, of Duchesne River at Myton, Utah, for 1909.

[Alice Todd, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	610	1,190	3,500	....	1,960	3,270	875	775	645
2	662	1,080	4,000	....	1,820	3,020	875	775	645
3	780	1,190	5,130	....	1,700	2,100	875	775	645
4	908	1,310	6,430	....	1,570	1,820	980	775	645
5	750	1,560	7,310	....	1,440	1,820	980	775	645
6	635	1,920	8,080	....	1,440	1,960	980	775	645
7	635	2,020	....	....	1,440	2,100	875	775	645
8	585	2,200	....	....	1,440	2,100	875	775	....
9	562	2,530	....	....	1,440	1,760	875	775	....
10	585	2,820	....	3,270	1,380	1,700	875	775	....
11	585	3,050	....	3,020	1,380	1.700	928	775	....
12	585	3,220	....	2,860	1,320	1,700	875	775	....
13	562	3,140	....	2.700	1,320	1,570	875	775	....
14	610	2,740	....	2,550	1,320	1,440	875	775	....
15	635	2,600	....	2,400	1,320	1,440	875	685	....
16	690	2,740	....	2,400	1,320	1,320	875	685	....
17	780	2,740	....	2,240	1,320	1,200	875	645	....
18	908	2,600	....	2,240	1,380	1,150	875	605	....
19	940	2,600	....	2,240	1,440	1,150	875	605	....
20	1,040	2.890	....	2,400	1,630	1,090	875	730	....
21	1,010	3,220	....	2.320	1,700	1,090	825	775	....
22	940	3,790	....	2,100	1,820	1,090	825	775	....
23	940	4,000	....	2,100	1,890	1,040	825	775	....
24	908	4,000	....	2,170	1,700	1,040	825	775	....
25	975	3,790	....	2,100	1,570	1,040	825	730	....
26	1,010	3,590	....	2,170	1,440	980	825	685	....
27	1,230	3,590	....	2,400	1,380	980	825	685	....
28	1,390	4,000	....	2,550	1,320	980	825	645	....
29	1,480	4,430	....	2,400	1,200	980	825	645	....
30	1,310	4,100	....	2,240	1,200	928	775	645	....
31	....	3,590	....	2,170	1,630	....	775	....	....

NOTE.—These discharges are based on rating tables applicable as follows: Apr. 1 to June 6, fairly well defined between 500 and 4,400 second-feet; July 10 to Dec. 7, defined by 1910 measurements between 300 and 1,200 second-feet.

Monthly discharge of Duchesne River at Myton, Utah, for 1909.

[Drainage area, 2,750 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
April	1,480	562	841	0.306	0.34	50,000	A.
May	4,430	1,080	2,850	1.04	1.20	175,000	A.
June 1-6	....	....	5,740	2.09	.47	68,300	B.
July 10-31	3,270	2,100	2,410	.876	.72	105,000	D.
August	1,960	1,200	1,490	.542	.62	91,600	C.
September	3,270	928	1,520	.553	.62	90,400	C.
October	980	775	866	.315	.36	53,200	C.
November	775	605	731	.266	.30	43,500	C.
December	....	....	[a] 637	.232	.27	39,200	D.
The period	....	....	....	....	....	716,000	

[a] Discharge estimated from Dec. 8 to 31 on basis of ice measurement made Dec. 22.

STRAWBERRY RIVER ABOVE MOUTH OF INDIAN CREEK IN STRAWBERRY VALLEY, UTAH.

A station was established on Strawberry River September 15, 1909, in the narrows below Strawberry Valley, about 3 miles above the mouth of Indian Creek and about half a mile below the dam site of the Strawberry Valley project, to determine the amount of water available for storage from Strawberry River for the Strawberry Valley project of the United States Reclamation Service. The station takes the place of the one previously maintained below Indian Creek. The new station is about 35 miles northeast of Thistle, Utah, the nearest railroad point.

The vertical staff gage is on the right bank directly underneath the cable from which discharge measurements are made.

Neither bank is liable to overflow except in extreme high water. The stream bed consists of coarse gravel and although rough is believed to be fairly permanent. The measuring conditions during the open-water season are good.

As to the lower station the river is frozen and deeply covered with snow about five months of the year. The flow during the winter is, however, fairly constant and a fair estimate of it may be made.

The following discharge measurement was made by E. S. Fuller:

September 15, 1909: Width, 44.5 feet; area, 54.4 square feet; gage height, 2.70 feet; discharge, 41.0 second-feet. Made by wading.

Daily gage height, in feet, and discharge, in second-feet, of Strawberry River above mouth of Indian Creek in Strawberry Valley, Utah, for 1909.

[J. C. Warfield, observer.]

Day.	October.		November.		Day.	October.		November.	
	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge.
1	....	37	2.75	43	16	....	37	....	41
2	....	38	....	43	17	2.6	37	....	41
3	2.65	39	....	42	18	....	37	....	41
4	....	40	....	42	19	....	38	....	41
5	2.7	41	....	41	20	....	38	....	41
6	....	41	2.7	41	21	....	39	....	41
7	2.7	41	....	41	22	2.65	39	3.1	41
8	....	41	....	41	23	....	39	....	41
9	2.7	41	....	41	24	....	39	....	41
10	....	41	....	41	25	2.65	39	....	41
11	2.7	41	....	41	26	....	39	....	41
12	....	40	2.7	41	27	....	40	....	41
13	2.65	39	....	41	28	....	40	....	41
14	....	39	....	41	29	....	41	....	41
15	....	38	....	41	30	2.7	41	....	41
					31	....	42	....	....

NOTE.—The daily discharges are based on a rating curve that is not well defined. Ice after Nov. 15.

Monthly discharge of Strawberry River in Strawberry Valley, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	42	37	39.4	2,420
November	43	41	41.2	2,450
December			40.0	2,460

NOTE.—These estimates are approximate.

STRAWBERRY RIVER BELOW MOUTH OF INDIAN CREEK IN STRAWBERRY VALLEY, UTAH.[1]

This station was originally located above the junction of Indian Creek and Strawberry River, where it was maintained from May 12, 1903, to July 12, 1906. On October 14, 1908, the station was reestablished at a point about 200 feet below the mouth of Indian Creek, where it was maintained until September 30, 1909, when it was discontinued and separate records were started on Indian Creek and Strawberry River. All of these stations are located at the lower end of Strawberry Valley, about 25 miles northeast of Thistle, the nearest railway point.

The records show the amount of water available for storage in the Strawberry Valley reservoir. Winters in this region are very severe, the river being frozen and covered deeply with snow about five months. The flow during this period, however, is fairly constant and a fair estimate of the winter flow may be made. Conditions during the open-water season are favorable for accurate measurements.

The gage is a vertical staff located 20 feet downstream from the cable and on the right bank. Discharge measurements are made from a car and cable.

Discharge measurements of Strawberry River below mouth of Indian Creek in Strawberry Valley, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 6	E. S. Fuller	64	273	11.2	1,380
July 7	.....do	39.5	58.8	6.61	196
Sept. 12	.....do	39	37.6	6.1	80.6

---

[1] This station was called "Strawberry River in Strawberry Valley, Utah," in previous reports.

Daily gage height, in feet, of Strawberry River below mouth of Indian Creek in Strawberry Valley, Utah, for 1909.

[J. C. Warfield, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	....	9.9	....	....	6.55	16	....	8.5	....	....	....
2	....	....	6.8	6.2	....	17	....	....	6.35	6.2	6.05
3	....	10.7	....	....	6.2	18	....	8.3	....	....	....
4	....	....	6.9	6.2	....	19	....	....	6.4	6.3	6.05
5	....	11.0	....	....	6.15	20	10.6	8.0	....	....	....
6	....	11.2	6.65	6.2	....	21	....	....	6.45	6.15	6.0
7	....	....	6.6	....	6.2	22	....	7.65	....	....	....
8	....	11.0	....	....	....	23	....	....	6.4	6.2	6.0
9	....	....	6.55	6.2	6.15	24	....	7.4	....	....	....
10	11.6	10.1	....	....	....	25	....	....	6.3	6.15	6.0
11	....	....	6.5	....	6.1	26	....	7.2	....	....	....
12	....	9.2	....	6.2	....	27	....	....	6.3	6.1	6.0
13	12.5	....	6.45	....	6.1	28	....	7.0	....	....	....
14	....	8.9	....	....	....	29	....	....	6.25	....	6.0
15	10.8	....	6.4	6.15	6.1	30	....	6.9	....	6.05	....
						31	10.0	....	6.2	....	....

NOTE.—Ice in January, February, March, and April.

Daily discharge, in second-feet, of Strawberry River below mouth of Indian Creek in Strawberry Valley, Utah, for 1909.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	20	1,020	251	101	182	16	1,260	660	142	96	72
2	20	1.140	239	101	142	17	1,250	635	136	101	67
3	205	1,250	251	101	101	18	1,240	610	142	112	67
4	390	1,290	263	101	96	19	1,230	572	147	124	67
5	575	1,330	234	101	90	20	1,220	535	152	107	62
6	760	1,390	204	101	96	21	1,200	492	158	90	56
7	945	1,360	193	101	101	22	1.190	443	152	96	56
8	1,130	1,330	188	101	96	23	1,170	416	147	101	56
9	1,320	1,200	182	101	90	24	1,160	385	136	96	56
10	1,500	1,080	176	101	84	25	1,140	360	124	90	56
11	1,580	960	170	101	78	26	1,120	335	124	84	56
12	1,660	842	164	101	78	27	1,110	311	124	78	56
13	1,750	803	158	98	78	28	1,100	287	118	75	56
14	1,510	764	152	94	78	29	1,080	275	112	71	56
15	1,270	712	147	90	78	30	1,070	263	106	67	58
						31	1,050	....	101	124	....

NOTE.—These discharges are based on a rating curve that is fairly well defined. Discharge interpolated for days when gage was not read.

Monthly discharge of Strawberry River below mouth of Indian Creek in Strawberry Valley, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May	1,750	20	1,070	65,800	D.
June	1,390	263	768	45.700	C.
July	263	101	164	10.100	C.
August	124	67	97.0	5.960	C.
September	182	56	78.8	4.690	C.

STRAWBERRY RIVER AT THEODORE, UTAH.

This station, which is located at the west boundary of the Theodore town site, along the wagon road to Heber, about 1¼ miles above the junction of the Strawberry with Duchesne River, about half a mile upstream from the mouth of Indian Canyon and about 18 miles below the mouth of Currant Creek, was established June 10, 1908, to determine the run-off of the lower Strawberry and the amount of water available for irrigation in that section. The drainage area above the station is nearly 1,200 square miles.

The chain gage is located about 50 feet downstream from cable from which discharge measurements are made. The datum of the gage has remained constant since the station was established.

Very good results should be obtained at this station except at extremely high stages, when the stream overflows the left bank, rendering it impossible to make gagings.

Discharge measurements of Strawberry River at Theodore, Utah, in 1909.

[By R. H. Fletcher.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 6	55	49	3.40	116	Aug. 10	62	149	3.50	341
21	52	60	4.00	147	26	61	136	3.40	267
Mar. 30	60	94	2.65	217	Sept. 9	62	140	3.38	325
Apr. 13	58	90	2.65	208	26	61	119	3.06	242
28	66	225	4.96	989	Oct. 8	62	121	2.97	228
May 25	128	475	7.80	[a] 3,920	25	61	113	2.91	209
July 11	63	189	4.15	540	Nov. 13	61	104	2.75	168
22	63	169	3.76	440	23	61	131	3.22	267

[a] Discharge estimated from extension of area and velocity curves.

Daily gage height, in feet, of Strawberry River at Theodore, Utah, for 1909.

[E. S. Winslow and M. M. Smith, observers.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.7	4.35	7.4	4.8	3.5	6.1	2.95	2.85	3.0
2	2.9	4.3	7.5	4.65	3.5	4.05	2.95	2.85	2.95
3	3.1	4.35	7.8	4.6	3.5	3.65	2.95	2.85	3.05
4	3.3	4.8	8.0	4.7	3.4	3.55	3.05	2.85	3.2
5	2.9	5.5	8.15	4.6	3.4	3.6	3.0	2.85	3.6
6	2.8	6.2	8.25	4.5	3.4	3.55	3.0	2.85	3.3
7	2.7	6.55	8.3	4.4	3.5	4.0	3.0	2.85	3.3
8	2.7	6.9	8.3	4.3	3.5	3.6	2.95	2.8	3.7
9	2.65	7.2	8.1	4.2	3.5	3.35	2.95	2.8	4.0
10	2.7	7.5	7.8	4.15	3.5	3.3	2.95	2.85	3.85
11	2.7	7.7	7.55	4.25	3.7	3.2	2.95	2.85	3.8
12	2.65	7.9	7.4	4.0	3.55	3.25	2.95	2.8	3.35
13	2.65	7.65	7.25	3.95	3.55	3.2	2.95	2.9	3.6
14	2.8	7.4	7.15	3.9	3.55	3.2	2.95	2.85	3.75
15	2.85	7.3	7.05	3.9	3.5	3.2	2.95	2.85	3.7
16	2.9	7.45	6.85	3.8	3.55	3.15	2.95	2.85	3.5
17	3.15	7.4	6.7	3.75	3.85	3.15	2.95	3.15	3.85
18	3.4	7.25	6.6	3.7	3.9	3.1	2.95	3.1	3.4
19	3.55	7.3	6.45	3.8	3.95	3.1	2.95	3.0	3.7
20	3.7	7.45	6.35	4.1	3.65	3.2	2.9	3.0	3.8
21	3.6	7.6	6.1	3.85	3.6	3.05	2.9	3.05	3.75
22	3.55	7.8	5.9	3.75	3.8	3.05	2.9	3.15	3.65
23	3.55	7.95	5.75	3.8	3.6	3.05	2.9	3.15	3.75
24	3.65	7.95	5.6	3.85	3.55	3.05	2.9	3.1	3.6
25	3.75	7.75	5.5	3.75	3.5	3.05	2.9	3.1	3.7
26	3.9	7.5	5.4	3.7	3.4	3.05	2.9	3.1	3.75
27	4.4	7.55	5.2	3.7	3.4	3.0	2.85	3.1	3.6
28	4.9	7.75	5.05	3.6	3.35	3.0	2.85	2.95	3.6
29	4.95	7.9	4.95	3.6	3.3	3.0	2.85	2.65	3.65
30	4.55	7.8	4.9	3.55	3.3	3.0	2.85	2.95	3.85
31	....	7.5	....	3.5	3.55	....	2.85	....	4.0

NOTE.—Ice in January, February, March, and from December 4 to 31.

Daily discharge, in second-feet, of Strawberry River at Theodore, Utah, for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	220	685	2.260	870	352	1,520	216	194	228
2	290	660	2,330	800	352	542	216	194	216
3	368	670	2.550	776	352	398	216	194	240
4	453	880	2,700	823	316	367	240	194	....
5	290	1,220	2,820	776	316	382	228	194	....
6	253	1,570	2,910	730	316	367	228	194	....
7	220	1,760	2,950	686	352	522	228	194	....
8	220	1,950	2,950	644	352	382	216	183	....
9	205	2,120	2.780	602	352	303	216	183	....
10	220	2,330	2,550	582	352	290	216	194	....
11	220	2,480	2,360	623	414	265	216	194	....
12	205	2,620	2,260	522	367	278	216	183	....
13	205	2.440	2,160	503	367	265	216	205	....
14	253	2,260	2,090	484	367	265	216	194	....
15	272	2,190	2,030	484	352	265	216	194	....
16	290	2,300	1,920	448	367	263	216	194	....
17	389	2,260	1,840	431	466	263	216	263	....
18	497	2,160	1,780	414	484	251	216	251	....
19	564	2,190	1,700	448	503	251	216	228	....
20	634	2,300	1,650	562	398	265	205	228	....
21	587	2,400	1,520	466	382	240	205	240	....
22	564	2,550	1,410	431	448	240	205	263	....
23	564	2,660	1,340	448	382	240	205	263	....
24	610	2,660	1,260	466	367	240	205	251	....
25	658	2,510	1,210	431	352	240	205	251	....
26	732	2,330	1.160	414	316	240	205	251	....
27	840	2,360	1,060	414	316	228	194	251	....
28	960	2,510	989	382	303	228	194	216	....
29	970	2,620	941	382	290	228	194	154	....
30	780	2,550	917	367	290	228	194	216	....
31	....	2,330	....	352	367	....	194	....	....

NOTE.—These discharges are based on rating curves applicable as follows: April 1 to April 26, well defined between 100 and 410 second-feet; April 27 to May 5, indirect method for shifting channels used; May 6 to Dec. 3, 1909, well defined between 160 and 960 second-feet.

Monthly discharge of Strawberry River at Theodore, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April	970	205	451	26,800	C.
May	2,660	660	2,080	128,000	D.
June	2,950	917	1,950	116,000	D.
July	870	352	541	33,300	C.
August	503	290	365	22,400	B.
September	1,520	228	335	19,900	B.
October	240	194	212	13,000	B.
November	263	154	214	12,700	B.
The period	....	....	....	372,000	

INDIAN CREEK IN STRAWBERRY VALLEY, UTAH.

This station, which was established April 5, 1905, discontinued July 12, 1906, and reestablished October 1, 1909, is located just above the mouth of the creek. The station was originally located about 250 feet above the mouth of the creek, but was reestablished in 1909, about half a mile farther upstream, in T. 4 S., R. 11 W. It is about 25 miles northeast of Thistle, Utah.

This point is below all tributaries, Trail Hollow Creek entering a few hundred feet above the new station. No water is diverted above the station. The records are of value to the United States Reclamation Service in connection with the Strawberry Valley project, which proposes to divert the waters of Indian Creek across a low pass into the Strawberry Valley reservoir.

The staff gage is driven vertically into the bed of the creek and braced to the right bank about 10 feet above a new footbridge from which measurements are made.

The river is frozen over and covered with a deep layer of snow during about five months of the year. The winter flow, however, is fairly constant and a fair estimate may be made. The open-water measuring conditions are excellent.

Discharge measurements of Indian Creek in Strawberry Valley, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Sept. 12	E. S. Fuller	22	20.7	1.60	31.3
15	do	21.5	18.5	1.55	29.7

Daily gage height, in feet, and discharge, in second-feet, of Indian Creek in Strawberry Valley, Utah, for 1909.

[J. C. Warfield, observer.]

Day.	October.		November.		Day.	October.		November.	
	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge.
1		23	1.4	23	16		23		23
2		24		23	17	1.4	23		23
3	1.45	25		23	18		23		23
4		25		23	19		23		23
5	1.45	25		23	20		23		23
6		26	1.4	23	21		23		23
7	1.5	27		23	22	1.4	23	1.48	23
8		27		23	23		23		23
9	1.5	27		23	24		23		23
10		26		23	25		23		23
11	1.45	25		23	26	1.4	23		23
12		25	1.4	23	27		23		23
13	1.45	25		23	28		23		23
14		25		23	29		23		23
15		24		23	30	1.4	23		23
					31		23		

NOTE.—The daily discharges are based on a rating curve that is not well defined. Discharge interpolated for days when gage was not read. Ice conditions after Nov. 15.

Monthly discharge of Indian Creek in Strawberry Valley, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	27	23	24.1	1,480
November	23	23	23.0	1,370
December			[a] 20.0	1,230

[a] Estimated.

NOTE.—These estimates are approximate.

TRAIL HOLLOW CREEK IN STRAWBERRY VALLEY, UTAH.

This station, which was established October 1, 1909, to determine the amount of water entering Indian Creek below the proposed point of diversion, is located just above the mouth of the stream. No water is at present diverted above the station. The records are of value to the United States Reclamation Service in that they show the portion of the flow of Indian Creek which can not be diverted into Strawberry Valley in connection with the Strawberry Valley project.

The staff gage is driven vertically into the bed of the stream and braced to the left bank. Discharge measurements can best be made by wading at ordinary stages, but during high water they can be made from a bridge made of two logs that is about 15 feet above the gauge.

The stream is frozen over and deeply covered with snow during about five months of the year.

The following discharge measurement was made by E. S. Fuller:

September 12, 1909: Width, 5.5 feet; area, 5.75 square feet; gage height, 3.40 feet; discharge, 4.84 second-feet. Made by wading.

Daily gage height, in feet and discharge, in second-feet, of Trail Hollow Creek in Strawberry Valley, Utah, for 1909.

[J. C. Warfield, observer.]

Day.	October.		November.		Day.	October.		November.	
	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge.
1		3.6	3.15	3.4	16		3.6		
2		3.6		3.4	17	3.2	3.6		
3	3.2	3.6		3.4	18		3.6		
4		3.6		3.4	19		3.5		
5	3.2	3.6		3.4	20		3.5		
6		3.6	3.15	3.4	21		3.4		
7	3.2	3.6		3.4	22	3.15	3.4	3.7	
8		3.6		3.4	23		3.4		
9	3.2	3.6		3.4	24		3.4		
10		3.6		3.4	25		3.4		
11	3.2	3.6		3.4	26	3.15	3.4		
12		3.6	3.15	3.4	27		3.4		
13	3.2	3.6		3.4	28		3.4		
14		3.6		3.4	29		3.4		
15		3.6		3.4	30	3.15	3.4		
					31		3.4		

NOTE.—These discharges are based on a curve that is not well defined. Discharges interpolated for days when gage was not read. Ice conditions after Nov. 15.

Monthly discharge of Trail Hollow Creek in Strawberry Valley, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	3.6	3.4	3.52	216
November			[a] 3.40	202
December			[a] 3.40	209

[a] Estimated.

NOTE.—These estimates are approximate.

LAKE FORK BELOW FORKS NEAR WHITEROCKS, UTAH.

This station, which is located about 500 feet downstream from the junction of the East and West forks, on the old Indian trail from Spanish Fork to Whiterocks, Utah, about 30 miles west of Whiterocks, was established on May 10, 1907, but a fragmentary record was maintained at the same place during 1904.

The station is above all present diversions and furnishes valuable data for determining the run-off and showing the amount of water available for irrigation below and storage above.

No important tributaries enter between this station and the mouth of the stream, and none on either branch for some distance above. The drainage area above the station is about 300 square miles.

The flow of this stream could doubtless be equalized at comparatively small expense by utilizing the storage facilities afforded by a number of the small lakes and reservoir sites found on both branches of the stream above the station. As both of the main tributaries have rapid fall, opportunities for power development are presented above all irrigation diversions.

The stream is icebound for several months each year.

The chain gage established May 10, 1907, has no relation whatever to the 1904 gage. Still another chain gage and datum have been used since September 1, 1907. This gage is located about 100 feet upstream from the cable from which discharge measurements are made.

As the stream bed is rough and the current is swift at high and moderate stages, the results obtained at this station can be considered only fair or approximate except at low stages, when they are fairly good.

Discharge measurements of Lake Fork below forks near Whiterocks, Utah, in 1909.

[By R. H. Fletcher.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 13[a]..	48	75	2.56	185	Aug. 27...	67	122	2.54	612
May 3...	54	79	1.75	243	Sept. 9...	74	138	2.88	777
24...	70	118	2.42	517	25...	62	96	2.18	333
June 16...	107	308	4.80	2,850	Oct. 7...	61	92	2.06	326
July 6...	100	216	3.80	1,530	26...	58	75	1.78	257
21...	84	141	2.75	768	Nov. 15...	57	76	1.64	224
Aug. 11...	68	121	2.65	632	24...	57	74	1.66	226

[a] Ice conditions. Measurement made partly from cable and partly from ice surface.

Daily gage height, in feet, of Lake Fork below forks near Whiterocks, Utah, for 1909.

[Charles and Paul J. Elliott, observers.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	1.7	2.5	4.25	2.3	3.9	2.0	1.65	1.6
2	1.5	1.7	2.85	4.2	2.55	3.6	2.0	1.65	1.65
3	1.5	1.75	3.55	4.2	2.45	3.3	2.05	1.65	1.55
4	1.45	1.9	4.35	4.1	2.3	3.1	2.1	1.65	1.5
5	1.5	2.0	4.75	4.0	2.3	3.1	2.1	1.55	1.3
6	1.5	2.0	4.85	3.95	2.35	3.2	2.1	1.6	1.3
7	1.4	2.05	4.9	3.65	2.4	3.1	2.3	....	1.5
8	1.4	2.1	4.5	3.4	2.4	3.0	2.0	....	1.5
9	1.4	2.2	4.4	3.4	2.45	2.9	2.0	....	....
10	1.35	2.2	4.15	3.2	2.65	2.9	1.95	1.65	....
11	1.4	2.2	4.2	3.2	2.45	2.8	1.95	1.6	....
12	1.4	2.1	4.35	3.1	2.7	2.7	1.9	1.6	....
13	1.4	2.05	4.55	3.0	2.7	2.7	1.9	1.6	....
14	1.5	2.0	4.5	2.9	2.45	2.6	1.9	1.65	2.55
15	1.5	2.0	4.6	2.8	2.45	2.5	1.9	1.6	2.6
16	1.6	2.0	4.7	2.8	2.6	2.5	1.85	1.6	2.8
17	1.7	2.0	4.9	2.65	3.05	2.4	1.85	1.6	2.8
18	1.7	2.0	4.95	2.7	3.1	2.4	1.85	1.6	2.7
19	1.7	2.1	4.9	2.9	2.95	2.35	1.85	1.65	....
20	1.7	2.2	4.3	2.9	3.0	2.3	1.8	1.7	....
21	1.65	2.3	4.2	2.7	3.25	2.25	1.8	1.7	....
22	1.6	2.5	4.35	2.65	3.0	2.2	1.8	1.7	....
23	1.6	2.5	4.6	2.7	3.0	2.2	1.8	1.65	....
24	1.6	2.4	4.85	2.65	2.75	2.2	1.8	1.65	....
25	1.6	2.3	4.6	2.6	2.65	2.15	1.8	1.6	....
26	1.75	2.3	4.4	2.9	2.6	2.1	1.8	1.6	....
27	1.9	2.45	4.5	3.0	2.55	2.1	1.7	1.55	....
28	1.8	2.6	4.5	2.65	2.4	2.05	1.7	1.6	....
29	1.85	2.5	4.55	2.5	2.4	2.05	1.7	1.6	....
30	1.75	2.45	4.3	2.4	2.3	2.05	1.7	1.6	....
31	....	2.4	....	2.3	2.65	....	1.7	....	....

NOTE.—Ice during January, February, and March, and from Dec. 9 to 31.

Daily discharge, in second-feet, of Lake Fork below forks near Whiterocks, Utah, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	160	180	170	196	236	550	2,120	445	1,710	317	226	215
2	160	180	170	196	236	775	2,060	580	1,400	317	226	226
3	160	180	170	196	248	1,350	2,060	522	1,120	335	226	206
4	170	180	170	187	287	2.240	1,940	445	955	352	226	196
5	170	180	170	196	317	2,790	1,820	445	955	352	206	160
6	175	170	170	196	317	2,930	1,760	470	1,040	352	215	160
7	175	170	170	178	335	3,000	1,450	495	955	445	[a] 218	196
8	175	170	170	178	352	2,440	1,210	495	880	317	[a] 221	196
9	180	170	170	178	395	2,310	1,210	522	810	317	[a] 224	195
10	180	170	170	169	395	2,000	1,040	642	810	302	226	200
11	180	160	180	178	395	2,060	1,040	522	740	302	215	190
12	185	160	180	178	352	2,240	955	675	675	287	215	180
13	185	160	180	178	335	2,510	880	675	675	287	215	195
14	180	160	180	196	317	2,440	810	522	610	287	226	195
15	180	160	180	196	317	2,580	740	522	550	287	215	195
16	185	150	180	215	317	2,720	740	610	550	274	215	195
17	185	150	175	236	317	3,000	642	918	495	274	215	190
18	185	150	170	236	317	3,070	675	955	495	274	215	180
19	190	150	170	236	352	3,000	810	845	470	274	226	175
20	190	150	170	236	395	2,180	810	880	445	260	236	165
21	190	160	160	226	445	2,060	675	1,080	420	260	236	180
22	190	160	160	215	550	2,240	642	880	395	260	236	185
23	190	160	160	215	550	2,580	675	880	395	260	226	185
24	190	160	160	215	495	2.930	642	708	395	260	226	185
25	190	160	160	215	445	2,580	610	642	374	260	215	185
26	190	170	150	248	445	2,310	810	610	352	260	215	185
27	190	170	150	287	522	2,440	880	580	352	236	206	185
28	190	170	150	260	610	2.440	642	495	335	236	215	185
29	190	....	150	274	550	2,510	550	495	335	236	215	185
30	190	....	170	248	522	2,180	495	445	335	236	215	185
31	190	....	180	....	495	....	445	642	....	236	....	185

[a] Interpolated.

NOTE.—Discharges Apr. 1 to Dec. 8 are based on a rating curve that is fairly well defined between 215 and 3,140 second-feet.

Discharges Jan. 1 to Mar. 31 and Dec. 9 to 31 estimated by hydrograph comparison of various streams in the Uinta River drainage.

Monthly discharge of Lake Fork below forks near Whiterocks, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January			182	11,200	D.
February			165	9,160	D.
March			168	10,300	D.
April	287	169	212	12,600	B.
May	610	236	393	24,200	B.
June	3,070	550	2,350	140,000	B.
July	2,120	445	1,030	63,300	B.
August	1,080	445	634	39,000	B.
September	1,710	335	668	39,700	B.
October	445	236	289	17,800	B.
November	236	206	220	13,100	B.
December			188	11,600	D.
The year			542	392,000	

LAKE FORK NEAR MYTON,[1] UTAH.

This station, which is located about 3 miles above Myton, Utah, was originally established July 3, 1900; was discontinued at the end of the season of 1903, and was reestablished in June, 1907. Several discharge measurements were, however, made in 1904.

As the station is only about half a mile above the junction of the stream with Duchesne River, the records show the amount of water which Lake Fork contributes to the Duchesne, and in connection with the records obtained at the station on Lake Fork below the forks, which is about 20 miles upstream and above all present diversions, they indicate also the amount of water diverted for irrigation along the stream. No important tributaries enter between the two stations.

Several canal systems built by the United States Indian Office take water from this stream above the station for irrigation. Some private canal systems are proposed or in operation. As at all other stations in this basin, the stream is icebound for several months during the winter season.

The gage was in the same position and the same datum was used from 1900 to 1904, inclusive. During 1907 and 1908 three distinct gages and datums were used—from June 13 to 30, 1907, from August 18 to December 31, 1907, and during 1908.

The results obtained during 1908 and 1909 have been very satisfactory, except for a few difficulties in the gage readings. Previous records are not so good.

Gage heights from June 15 to 21 are too uncertain, owing to the settlement of the gage, to warrant publication. On June 22 the gage was removed to the opposite bank and reinstalled at a different datum. Gage heights, beginning June 22, are therefore not comparable with those of previous dates.

---

[1] Described in early reports as "Lake Fork at mouth."

Discharge measurements of Lake Fork near Myton, Utah, in 1909.

[By R. H. Fletcher.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 7[a]	66	107	4.55	178	June 23	70	429	6.90	2,470
20[a]	66	128	4.68	207	July 10	66	234	3.90	724
Feb. 16[a]	66	113	4.60	149	23	66	185	3.18	398
26[a]	66	116	4.65	180	Aug. 9	66	162	2.80	286
Mar. 16[a]	66	116	4.00	183	26	66	183	3.14	385
29[b]	65	118	3.59	144	Sept. 8	67	230	3.89	726
Apr. 12	65	107	3.46	113	26	66	149	2.76	258
28	65	134	3.90	191	Oct. 8	66	142	2.61	226
May 12[c]	65	152	....	265	23	66	125	2.35	165
25	65	167	4.45	327	Nov. 12	66	122	2.25	143
June 9	70	375	7.50	2,070	22	66	135	2.48	178
22	70	360	6.04	1,860	Dec. 22	64	124	3.15	183

[a] Measurement made through ice.
[b] Measurement from cable; some ice in section.
[c] Gage out of order.

NOTE.—Ice on Jan. 7, 1.2 feet thick; Jan. 20, 1.4 feet thick; Feb. 16, 1.8 feet thick; Feb. 26, 2.0 feet thick; Mar. 16, 2.0 feet thick; Dec. 22, 1.0 foot thick.

Daily gage height, in feet, of Lake Fork near Myton, Utah, for 1909.

[James E. Pitts, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.6	3.8	4.55	6.35	2.6	5.65	2.5	2.2	2.35
2	3.6	3.7	4.8	5.8	2.85	5.05	2.5	2.2	2.35
3	3.65	3.7	6.8	5.7	2.8	4.4	2.45	2.2	2.35
4	3.6	3.8	7.9	5.45	2.65	4.0	2.45	2.2	2.1
5	3.5	3.9	7.85	5.2	2.6	3.85	2.65	2.2	2.1
6	3.45	4.05	....	5.0	2.7	4.0	2.65	2.2	2.3
7	3.5	4.1	8.5	4.7	2.9	4.1	2.6	2.2	2.3
8	3.5	4.1	7.75	4.3	3.0	3.9	2.6	2.2	2.45
9	3.5	4.15	7.3	4.05	2.8	3.65	2.55	2.2	2.45
10	3.5	....	6.9	3.95	2.85	3.7	2.55	2.2	2.5
11	....	....	7.0	3.8	3.0	3.55	2.55	2.2	2.3
12	3.5	....	7.2	3.6	3.0	3.5	2.5	2.2	2.5
13	3.5	....	7.4	3.5	3.0	3.4	2.45	2.2	2.5
14	3.55	....	7.5	3.4	3.0	3.3	2.45	2.25	2.5
15	3.6	....	....	3.3	2.75	3.2	2.4	2.3	2.6
16	3.6	....	....	3.2	3.0	3.2	2.35	2.3	2.5
17	3.7	4.0	....	3.15	4.55	3.05	2.4	2.3	2.4
18	3.7	4.0	....	3.15	3.85	3.05	2.4	2.35	2.4
19	3.8	4.05	....	3.3	3.6	3.0	2.35	2.5	2.25
20	3.8	4.2	....	3.4	3.55	3.0	2.35	2.5	2.55
21	3.8	4.35	....	3.3	3.5	2.9	2.35	2.5	2.8
22	3.7	4.45	6.0	3.15	3.6	2.85	2.35	2.4	2.8
23	3.7	4.6	6.75	3.05	3.55	2.85	2.4	2.45	....
24	3.6	4.6	7.1	3.3	3.5	2.8	2.4	2.45	2.5
25	....	4.5	6.9	3.15	3.15	2.7	2.3	2.45	3.0
26	3.7	4.45	6.5	3.2	3.1	2.75	2.3	2.4	3.1
27	....	4.5	6.4	3.7	3.0	2.7	2.3	2.4	3.1
28	3.9	4.65	6.35	3.3	3.0	2.65	2.3	2.35	3.1
29	3.9	4.7	6.45	3.05	2.85	2.55	2.3	2.35	3.1
30	3.8	4.7	6.25	2.9	2.8	2.45	2.3	2.3	3.1
31	....	4.5	....	2.75	3.2	....	2.3	....	3.1

NOTE.—Ice conditions during Jan., Feb., Mar., and on Dec. 15 and from Dec. 19 to 31. Owing to settlement of the gage, gage heights June 15 to 21 are too uncertain to warrant publishing. New gage established on June 22. Gage heights after this date are not comparable with those before this date.

Daily discharge, in second-feet, of Lake Fork near Myton, Utah, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	175	185	180	142	172	358	2,080	215	1,610	190	130	160
2	175	185	180	142	156	455	1,710	285	1,250	190	130	160
3	175	185	180	149	156	1,580	1,640	270	915	180	130	160
4	175	180	180	142	172	2,360	1,490	228	735	180	130	115
5	175	180	180	130	190	2,330	1,340	215	668	228	130	115
6	175	175	180	124	221	2,580	1,220	240	735	228	130	150
7	178	175	180	130	232	2,840	1,060	300	780	215	130	150
8	180	170	180	130	232	2,250	870	335	690	215	130	180
9	180	170	180	130	244	1,930	758	270	580	202	130	180
10	180	170	180	130	240	1,650	712	285	600	202	130	190
11	180	165	180	130	235	1,720	645	335	540	202	130	150
12	185	165	180	130	230	1,860	560	335	520	190	130	190
13	185	160	180	130	226	2,000	520	335	480	180	130	190
14	185	160	180	136	222	2,070	480	335	440	180	140	190
15	185	155	180	142	218	2,140	440	255	405	170	150	190
16	190	149	183	142	214	2,140	405	336	405	160	150	190
17	190	150	180	156	210	2,680	388	990	352	170	150	170
18	195	150	175	156	210	2,920	388	668	352	170	160	170
19	200	155	170	172	221	2,680	440	560	335	160	190	140
20	207	155	160	172	256	2,140	480	540	335	160	190	170
21	205	160	160	172	296	1,720	440	520	300	160	190	180
22	205	165	160	156	325	1,840	388	560	285	160	170	183
23	205	165	155	156	375	2,360	352	540	285	170	180	180
24	200	170	155	142	375	2,620	440	520	270	170	180	180
25	200	175	155	149	340	2,470	388	388	240	150	180	180
26	195	180	150	156	325	2,180	405	370	255	150	170	180
27	195	180	150	173	340	2,110	600	335	240	150	170	180
28	195	180	150	190	395	2,080	440	335	228	150	160	180
29	190	....	144	190	415	2,140	352	285	202	150	160	180
30	190	....	140	172	415	2,000	300	270	180	150	150	180
31	190	....	140	....	340	....	255	405	....	150	....	180

NOTE.—These discharges are based on rating curves applicable as follows: Apr. 1 to June 21, fairly well defined between discharges of 120 and 2,440 second-feet. June 22 to Dec. 19, well defined between discharges of 115 and 2,920 second-feet. Discharges during Jan., Feb., Mar., June 15 to 22, and Dec. 20 to 31 estimated directly from measurements and hydrographs.

Monthly discharge of Lake Fork near Myton, Utah, for 1909.

[Drainage area, 475 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	....	....	189	0.398	0.46	11,600	C.
February	....	....	168	.354	.37	9,330	C.
March	....	....	169	.356	.41	10,400	C.
April	190	124	149	.314	.35	8,870	A.
May	415	156	264	.556	.64	16,200	B.
June	2,920	358	2,070	4.36	4.86	123,000	B.
July	2,080	255	709	1.49	1.72	43,600	A.
August	990	215	383	.806	.93	23,600	A.
September	1,610	180	507	1.07	1.19	30,200	A.
October	228	150	177	.373	.43	10,900	A.
November	190	130	151	.318	.35	8,980	A.
December	....	....	171	.360	.42	10,500	A.
The year	....	....	426	.896	12.13	307.000	C.

UINTA RIVER NEAR WHITEROCKS, UTAH.

This station was originally established in connection with the investigation for the water supply of the Uinta Reservation, on September 16, 1899, and the records were continued until the latter part of 1904. It was reestablished in the same locality on August 13, 1907.

The present station is located at the highway bridge on the Government road up Uinta Canyon, usually known as the sawmill road. The bridge is about 8 miles northwest of the Indian agency at Whiterocks. Previous records were taken at points a short distance upstream from this bridge.

The station is situated about a mile below the mouth of Pole Creek. The Whiterocks comes in several miles below, but there are no other tributaries except some dry gulches which occasionally carry considerable flood water.

No water is diverted from the stream above the station, but the United States Indian Office has constructed a series of irrigation canals, which divert water at various points below. The upper reaches of this stream present excellent opportunities for storage and power development.

The results at the station are affected by ice during the winter season. Winter measurements are usually taken at riffles or open places in the channel.

The same gage was used from 1899 to 1904, inclusive. The gage established in August, 1907, was located a short distance upstream from the old gage, and at a different datum. The present chain gage has no determined relation to this last gage. It was established on October 22, 1907, and is located on the bridge about a mile downstream from the other gage.

The gage is read only when the hydrographer visits the station to make discharge measurements, and the discharges for intermediate days are estimated by comparison with the hydrographs of other streams in that locality.

As the stream bed is rough and the current swift at high and moderate stages, the discharge measurements, except at low stages, are apt to be considerably in error.

Discharge measurements of Uinta River near Whiterocks, Utah, in 1909.

[By R. H. Fletcher.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 15[a]	66	120	2.55	194	July 15	78	123	1.85	451
26[a]	66	92	1.75	182	27	81	148	2.35	795
Feb. 6[a]	66	81	1.47	83	Aug. 3	74	113	1.80	464
18[a]	60	53	.90	103	16	78	130	2.10	602
Mar. 9	61	57	.95	133	30	75	113	1.80	447
20	66	62	1.00	136	Sept. 3	84	160	2.30	790
Apr. 3	66	67	1.00	156	14	74	128	2.00	524
16	69	71	1.10	177	28	72	108	1.72	369
May 6	70	92	1.34	268	Oct. 4	73	108	1.70	372
19	72	107	1.56	362	21	73	86	1.45	226
29	75	118	1.75	477	30	71	82	1.45	196
June 3	83	166	2.42	1,060	Nov. 8	71	85	1.40	193
14	84	204	2.63	1,270	18[a]	67	85	1.42	193
25	83	186	3.00	1,250	30[a]	67	84	1.40	178
July 2	85	160	2.60	809	Dec. 17[a]	60	151	3.15	164

[a] Ice conditions.

Daily discharge, in second-feet, of Uinta River near Whiterocks, Utah, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	195	120	120	140	220	470	1,040	500	600	360	200	175
2	195	100	120	140	215	485	1,030	470	680	360	200	175
3	195	100	120	140	220	1,060	1,000	415	772	360	200	175
4	195	100	120	160	235	1,720	960	410	800	360	200	175
5	195	90	120	160	245	2,080	940	400	780	340	200	175
6	195	83	125	160	268	2,400	920	395	770	320	195	170
7	195	85	125	160	285	2,380	900	395	770	315	195	170
8	195	85	125	160	320	2,280	880	400	760	300	193	170
9	195	85	125	160	325	1,880	760	420	720	290	195	170
10	195	85	135	160	330	1,440	640	440	680	280	195	170
11	195	90	135	160	330	1,320	560	465	660	280	190	165
12	195	90	135	160	320	1,220	520	485	620	280	190	165
13	195	90	135	160	310	1,220	500	480	560	280	190	165
14	195	90	135	165	300	1,270	475	480	540	270	190	165
15	194	90	135	170	290	1,340	445	500	510	260	190	165
16	195	90	135	175	280	1,400	440	615	490	255	190	165
17	195	95	135	200	280	1,440	460	640	470	250	190	164
18	195	110	135	215	290	1,520	485	650	460	240	193	160
19	195	105	135	215	362	1,540	515	680	450	235	190	160
20	195	105	140	215	325	1,480	515	700	440	230	190	160
21	195	105	135	210	380	1,400	500	700	430	230	190	160
22	195	110	135	200	430	1,340	480	660	420	220	190	160
23	195	110	135	190	430	1,340	480	560	400	225	190	160
24	195	110	135	190	420	1,380	520	480	390	225	190	160
25	180	110	135	200	415	1,390	580	430	380	230	190	160
26	182	110	135	205	415	1,320	660	400	370	230	180	160
27	175	110	135	235	420	1,240	815	400	370	230	180	160
28	170	110	135	235	435	1,200	760	400	369	220	180	160
29	160	....	135	230	477	1,120	720	420	360	210	180	160
30	120	....	135	225	455	1,080	630	415	360	196	178	160
31	120	....	135	....	445	....	560	500	....	200	....	160

NOTE.—Daily discharges were obtained by comparison with hydrographs of Lake Fork below forks, and Uinta River at Fort Duchesne. Feb. 15 to Oct. 25 discharges, on dates of actual measurements, obtained by applying gage heights of these measurements to curves instead of using actual discharge.

Monthly discharge of Uinta River near Whiterocks, Utah, for 1909.

[Drainage area, 218 square miles.]

Month.	Discharge in second-feet.		Run-off.	
	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	187	0.858	0.99	11.500
February	98.7	.453	.47	5,480
March	131	.601	.69	8,060
April	183	.839	.94	10,900
May	338	1.55	1.79	20,800
June	1,430	6.56	7.32	85,100
July	667	3.06	3.53	41,000
August	494	2.27	2.62	30,400
September	546	2.50	2.79	32,500
October	267	1.22	1.41	16,400
November	191	.876	.98	11.400
December	165	.757	.87	10.100
The year	391	1.80	24.40	284,000

NOTE.—The accuracy of these estimates may be classed as C.

UINTA RIVER AT FORT DUCHESNE, UTAH.

This station, which is located at the wooden highway bridge on the road to Vernal, one-fourth of a mile from Fort Duchesne, Utah, was originally established on September 4, 1899, and continued until the end of 1904. It was also maintained for a brief period during 1906, and on April 9, 1907, the station was reestablished.

The data obtained at this point show the amount of water contributed by this stream to Duchesne River, except the comparatively small amount diverted for irrigation below, and in connection with the records of the stations above on the Whiterocks and the Uinta, they show the amount of water taken for irrigation by the numerous diversions both on the Uinta and Whiterocks above the station. The upper tributaries, above irrigation diversions, afford excellent opportunities for storage and power development.

The flow of the stream is affected by ice for about four months during the winter season, and the accuracy of the results is somewhat affected by eddies around the crib piers and by deposits of sediment brought down by Deep Creek during floods.

Practically the same datum was used for the gage up to and including 1906. The present chain gage, established April 9, 1907, has an entirely different datum. This gage is fastened to the bridge from which discharge measurements are made.

Discharge measurements of Uinta River at Fort Duchesne, Utah, in 1909.

[By R. H. Fletcher.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 4 [a]	40	64	7.50	170	July 7	80	399	7.10	572
28 [a]	40	74	6.84	127	23	80	372	6.65	308
Feb. 10 [a]	35	57	7.60	128	Aug. 7	80	353	6.50	188
Mar. 13 [a]	35	61	6.90	116	25	80	368	6.90	386
27	80	316	6.60	222	Sept. 6	80	438	7.85	1,470
Apr. 6	78	288	6.37	161	22	80	388	6.92	4[illegible]6
29	79	273	6.49	197	Oct. 9	80	353	6.66	287
May 11	80	225	6.80	378	22	80	350	6.55	200
26	80	230	6.82	409	Nov 11 [b]	79	89	6.54	229
June 8	80	490	8.27	2,780	20 [b]	85	111	6.38	188
21	80	444	7.82	1,460	Dec. 21 [b]	105	135	7.10	171

[a] Ice; measurements made through holes cut in ice. [b] Made by wading.

NOTE.—Ice at gage on Jan. 4, 1.6 feet thick; Jan. 28, 2.5 feet thick; Feb. 10, 3 feet thick; Dec. 21, 1.4 feet thick.

Daily gage height, in feet, of Uinta River at Fort Duchesne, Utah, for 1909.

[Bertha L. Wouldhave, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.45	6.4	6.85	7.55	6.5	7.6	6.7	6.5	6.5
2	6.5	6.45	7.15	7.3	6.4	7.9	6.65	6.5	6.5
3	6.5	6.45	7.8	7.3	6.5	7.55	6.65	6.5	6.4
4	6.5	6.45	8.15	7.3	6.4	7.35	6.7	6.5	6.35
5	6.4	6.5	8.75	7.3	6.4	7.6	6.7	6.5	6.3
6	6.35	6.55	8.8	7.4	6.45	7.85	6.7	6.5	6.25
7	6.4	6.65	8.65	7.25	6.45	7.65	6.7	6.5	6.5
8	6.35	6.65	8.15	7.05	6.45	7.6	6.7	6.4	6.55
9	6.4	6.65	8.25	7.0	6.45	7.5	6.65	6.4	6.6
10	6.4	6.75	7.9	6.9	6.4	7.45	6.6	6.6	6.6
11	6.4	6.75	7.75	6.85	6.4	7.4	6.6	6.5	6.7
12	6.35	6.7	7.8	6.7	6.4	7.5	6.6	6.5	6.6
13	6.35	6.65	7.95	6.6	6.6	7.3	6.6	6.5	6.55
14	6.4	6.65	7.85	6.6	6.55	7.2	6.6	6.5	6.8
15	6.4	6.55	8.05	6.6	6.45	7.15	6.55	6.5	6.8
16	6.45	6.55	7.85	6.6	6.6	7.1	6.55	6.5	6.7
17	6.5	6.55	8.15	6.5	7.1	7.1	6.5	6.4	6.7
18	6.5	6.55	8.25	6.45	7.15	7.0	6.5	6.45	6.75
19	6.5	6.55	8.1	6.6	7.0	7.0	6.5	6.4	6.6
20	6.5	6.65	7.95	6.9	6.9	6.95	6.5	6.4	6.75
21	6.5	6.75	7.85	6.75	6.9	6.9	6.5	6.4	6.7
22	6.4	6.85	7.85	6.6	6.9	6.9	6.5	6.4	7.45
23	6.4	6.85	7.8	6.6	6.8	6.9	6.5	6.45	7.6
24	6.4	6.85	7.95	6.75	6.75	6.9	6.5	6.4	7.4
25	6.4	6.85	7.95	6.6	6.8	6.8	6.5	6.45	7.3
26	6.4	6.75	7.75	6.6	6.7	6.8	6.55	6.45	7.3
27	6.4	6.85	7.7	7.1	6.7	6.7	6.5	6.6	7.3
28	6.4	7.05	7.7	6.9	6.7	6.65	6.5	6.5	7.3
29	6.6	7.05	7.65	6.65	6.6	6.65	6.5	6.45	7.25
30	6.5	7.00	7.6	6.6	6.6	6.7	6.5	6.5	7.35
31	....	6.85	....	6.5	6.8	....	6.5	....	7.25

NOTE.—Probable ice conditions Jan. 1 to Mar. 31 and Dec. 7 to 31.

Daily discharge, in second-feet, of Uinta River at Fort Duchesne, Utah, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	160	120	120	192	175	412	1,090	210	1,160	310	210	210
2	160	120	120	210	192	685	775	175	1,620	282	210	210
3	165	125	115	210	192	1,660	775	210	1,090	282	210	175
4	170	125	110	210	192	2,460	775	175	835	310	210	160
5	165	125	100	175	210	4,300	775	175	1,160	310	210	145
6	165	125	100	160	232	4,470	895	192	1.540	310	210	132
7	160	125	100	175	282	3,980	720	192	1.230	310	210	140
8	160	125	100	160	282	2,460	518	192	1.160	310	175	150
9	160	125	100	175	282	2,740	472	192	1,020	282	175	160
10	160	128	100	175	342	1,860	392	175	858	255	255	170
11	160	125	110	175	342	1,560	358	175	895	255	210	170
12	160	125	115	160	310	1,660	264	175	1,020	255	210	170
13	160	125	116	160	282	1,970	213	255	775	255	210	170
14	160	125	118	175	282	1,760	213	232	665	255	210	170
15	160	125	120	175	232	2,210	213	192	614	232	210	170
16	160	125	140	192	232	1.540	255	213	630	232	210	170
17	155	125	160	210	232	2.070	210	563	630	210	175	170
18	155	125	160	210	232	2.260	192	614	535	210	192	170
19	155	125	170	210	232	1,980	255	472	535	210	175	170
20	150	125	180	210	282	1,710	450	392	492	210	175	170
21	150	125	190	210	342	1,540	342	392	450	210	175	170
22	150	125	195	175	412	1,540	255	392	450	210	175	170
23	150	125	200	175	412	1,460	255	323	450	210	192	170
24	140	125	200	175	412	1,710	342	294	450	210	175	170
25	140	125	200	175	412	1,710	255	323	375	210	192	170
26	130	125	210	175	342	1,380	255	264	375	232	192	170
27	130	125	222	175	412	1,300	630	264	310	210	255	170
28	127	125	210	175	582	1,300	450	264	282	210	210	170
29	120	....	200	255	582	1,230	282	213	282	210	192	170
30	120	....	180	210	535	1,160	255	213	310	210	210	170
31	120	....	160	....	412	....	210	323	....	210	....	170

Monthly discharge of Uinta River at Fort Duchesne, Utah, for 1909.

[Drainage area, 672 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	....	....	151	0.225	0.26	9,280	C.
February	....	....	125	.186	.19	6,940	C.
March	....	....	149	.222	.26	9,160	C.
April	255	160	187	.278	.31	11,100	B.
May	582	175	319	.475	.55	19,600	B.
June	4,470	412	1,940	2.89	3.22	115,000	C.
July	1,090	192	430	.640	.74	26,400	C.
August	614	175	272	.405	.47	16,700	B.
September	1,540	282	740	1.10	1.23	44,000	B.
October	310	210	246	.366	.42	15,100	B.
November	255	175	201	.299	.33	12,000	B.
December	....	....	168	.250	.29	10,300	D.
The year	....	....	411	.611	8.27	296,000	

NOTE.—These discharges were obtained from rating curves applicable as follows: Apr. 1 to June 15, July 16 to Aug. 15, and Sept. 16 to Dec. 6, fairly well defined between 120 and 3,500 second-feet; June 16 to July 15 and Aug. 16 to Sept. 15, not well defined. Discharges Jan., Feb., Mar., and Dec. 7 to 31 were estimated by hydrograph comparison with other streams in the vicinity of the gaging station.

WHITEROCKS RIVER NEAR WHITEROCKS, UTAH.

This station, which is located at the mouth of the canyon at the foot of "Dugway" on the road from the plateau to the river bottom, about 10 miles above the Indian agency at Whiterocks, was established April 18, 1899, and continued until the end of 1904. On April 11, 1907, it was reestablished at practically the same place.

The information contained here is valuable in connection with general studies of run-off problems and to show the amount of water available for storage and power above and for irrigation below.

The station is below all important tributaries of the Whiterocks. The first diversion for irrigation is about 3 miles below the station. Excellent storage and power sites exist above all irrigation diversions.

Like other streams in this region, the river is icebound for several months in the winter.

The same gage and datum were used from the establishment of the station until the end of 1904. A new chain gage and datum were used from April 11, 1907, to May 8, 1908, and the present chain gage, at a still different datum, has been used since May 9, 1908. Measurements are made from a cable about 100 feet downstream from the gage.

Owing to the remoteness of this gage from any dwelling, daily gage observations have not been made, and daily and monthly discharges have been obtained by comparing the relatively frequent discharge measurements with the hydrographs of other streams in that section.

As the stream bed is rather rough and the current is swift, measurements at high or medium stages are not very accurate. The daily and monthly discharge estimates, computed by the method outlined above, are necessarily only approximate.

Discharge measurements of Whiterocks River near Whiterocks, Utah, in 1909.

[By R. H. Fletcher.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 11[a]...	30	51	2.32	50	July 28....	44	60	2.12	277
27[a]...	31	65	2.58	73	Aug. 5....	34	47	1.80	183
Feb. 4[b]...	30	43	1.62	61	23....	45	73	2.20	330
Mar. 10[b]...	30	34	1.45	51	Sept. 2. ..	55	111	2.90	603
22....	30	30	1.02	57	13....	50	82	2.38	373
Apr. 5....	30	32	1.10	60	29....	35	47	1.85	177
17....	31	39	1.30	102	Oct. 5....	34	46	1.84	161
May 7....	32	46	1.58	145	20....	33	40	1.50	105
21....	45	64	2.10	280	29....	33	33	1.45	96
31....	50	76	2.30	372	Nov. 6[b]...	31	34	1.38	66
June 12....	58	130	3.30	774	17[b]...	33	36	1.50	92
26....	55	104	2.80	533	26[b]...	33	34	1.40	73
July 3....	52	88	2.55	435	Dec. 16[c]...	33	46	1.30	67
17....	37	53	1.95	211					

[a] Backwater effect at gage due to ice.
[b] Slight ice conditions.
[c] Considerable ice in river.

Daily discharge, in second-feet, of Whiterocks River near Whiterocks, Utah, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	50	65	50	80	80	370	440	180	400	180	80	60
2	50	65	50	80	80	400	435	180	603	180	80	60
3	50	65	50	65	80	440	435	180	760	170	75	60
4	50	61	50	60	100	600	440	180	720	170	75	60
5	50	55	50	62	120	1,600	480	185	680	178	70	60
6	50	55	50	50	125	1,960	500	180	680	160	66	60
7	50	50	50	50	147	2,020	400	190	700	160	60	60
8	50	50	50	50	160	1,900	340	190	690	160	60	60
9	50	50	50	60	180	1,000	260	180	660	160	60	60
10	50	50	51	60	185	800	200	170	600	160	70	60
11	50	50	50	60	180	750	180	170	520	160	75	65
12	50	50	50	60	175	774	180	170	460	160	80	65
13	50	50	50	60	170	840	180	170	373	150	80	65
14	50	50	50	70	170	960	190	170	360	150	85	65
15	50	50	50	80	160	1,080	200	170	360	140	90	65
16	55	50	55	85	170	1,120	200	170	370	120	90	67
17	55	50	55	92	180	1,120	227	240	370	120	92	65
18	55	50	55	105	190	1,080	210	400	370	120	80	65
19	55	50	55	105	200	1,380	200	380	350	115	80	60
20	60	50	60	90	220	800	200	360	350	105	75	60
21	60	50	60	100	290	780	220	330	340	100	70	60
22	60	50	57	80	320	800	220	330	340	100	70	60
23	65	50	60	80	340	840	220	325	330	100	60	60
24	65	50	60	80	320	800	220	350	320	100	60	60
25	70	50	60	80	320	640	220	350	280	100	60	60
26	70	50	60	80	300	538	235	330	240	100	73	60
27	73	50	65	80	320	480	275	320	220	100	60	60
28	70	50	65	85	330	440	280	300	200	90	60	60
29	70	....	65	85	370	440	190	280	180	95	60	60
30	65	....	70	80	370	440	180	280	180	90	60	60
31	65	....	70	....	372	....	180	320	....	80	....	60

NOTE.—The daily discharges were obtained by comparison of hydrographs of Lake Fork below forks and Uinta River at Fort Duchesne.

Discharges on dates of actual measurements obtained by applying gage heights of these measurements to rating tables from Apr. 1 to Oct. 31.

Monthly discharge of Whiterocks River near Whiterocks, Utah, for 1909.

[Drainage area, 114 square miles.]

Month.	Discharge in second-feet.		Run-off.	
	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	56.9	0.499	0.58	3,500
February	52.4	.460	.48	2,910
March	55.6	.488	.56	3,420
April	75.1	.659	.74	4,470
May	217	1.90	2.19	13,300
June	908	7.96	8.88	54,000
July	269	2.36	2.72	16,500
August	249	2.18	2.51	15,300
September	434	3.81	4.25	25,800
October	131	1.15	1.33	8,060
November	71.9	.631	.70	4,280
December	61.4	.538	.62	3,780
The year	215	1.89	25.56	155,000

NOTE.—The accuracy of these estimates may be classed as C.

PRICE RIVER BASIN.

DESCRIPTION.

Price River rises in the Wasatch Mountains, in the southeastern part of Utah County, flows in a generally southeasterly direction and unites with Green River at a point about 14 miles above Greenriver, Utah. The main source of supply is the snow in the upper reaches of the basin, where elevations range from 8,000 to 9,000 feet. The region is extremely rough and rugged. The predominant rock is a loose and badly disintegrated sandstone. The soil is scanty and supports practically no vegetation except small groves of scrubby cedar and a few scattered pines. The original sparse underbrush and grass have been almost entirely tramped out by sheep and cattle.

The river is subject to floods in the spring and early summer, during which time it carries immense quantities of sediment. Gordon and Pleasant creeks, the principal tributaries, are both short, steep streams and enter from the west almost at right angles.

PRICE RIVER NEAR HELPER, UTAH.

This station, which was established February 21, 1904, is located at an old ford crossing in the settlement of Spring Glen, about 3 miles south of Helper, Utah, and about 350 feet west of the tracks of the Denver & Rio Grande Railroad.

This station is below Pleasant Creek and White River, the two principal tributaries above, and is above Gordon Creek, which enters about 5 miles below, and Grassy Trail Creek, which enters about 35 miles below. There are no important diversions above. Records indicate the amount of water available for the Price River Irrigation Co. and for the canals for the town of Price.

Discharge measurements are made from a car and cable.

The datum of the original chain gage remained unchanged until the gage was washed out by high water April 11, 1907. It was replaced by a temporary gage June 23, 1907, and by a permanent gage July 16, 1907. All gage heights after June 22, 1907, are referred to a new datum 0.7 foot above the original datum.

A fair estimate may be made of winter flow, though ice is usually rather heavy. The bed of the stream is somewhat shifting, but the records may, on the whole, be considered good.

Discharge measurements of Price River near Helper, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 19	E. A. Porter	61	209	4.30	696
Sept. 23	.....do	51	67.2	3.00	101
Nov. 4	.....do	50	53.9	2.80	53.3

Daily gage height, in feet, of Price River, near Helper, Utah, for 1909.

[Andy Woolsey, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	2.4	3.0	3.0	3.9	5.0	3.6	3.0	5.0	2.9	2.8	2.75
2	2.5	2.4	2.9	3.2	3.9	5.1	3.6	3.0	3.4	2.8	2.8	2.8
3	2.5	2.4	2.8	3.3	4.0	5.5	3.5	3.0	3.3	2.9	2.8	2.8
4	2.5	2.4	2.8	3.6	4.3	5.7	3.6	3.0	3.1	2.9	2.8	2.8
5	2.5	2.5	2.8	3.5	4.5	5.8	3.5	3.0	3.1	2.9	2.8	2.8
6	2.6	2.5	2.7	3.4	4.6	5.9	3.4	3.0	3.2	2.9	2.8	2.8
7	2.6	2.4	2.8	3.3	4.8	5.9	3.3	3.1	3.3	2.9	2.8	2.8
8	2.6	2.4	2.7	3.2	4.9	5.8	3.2	3.1	3.2	3.0	2.8	2.8
9	2.6	2.4	2.9	3.2	5.0	5.6	3.2	3.1	3.0	2.9	2.8	2.6
10	2.6	2.4	2.8	3.3	5.1	5.2	3.2	3.2	3.0	2.9	2.8	2.6
11	2.5	2.4	2.7	3.4	5.2	5.0	3.2	3.2	3.0	2.9	2.8	......
12	2.6	2.4	2.7	3.3	5.2	4.9	3.1	3.1	3.0	2.9	2.8	2.6
13	2.6	2.4	2.7	3.3	4.9	4.8	3.1	3.1	3.0	3.0	2.8	2.7
14	2.6	2.5	2.7	3.6	4.8	4.8	3.1	3.1	3.0	2.9	2.8	2.8
15	2.6	2.5	2.6	3.7	4.7	4.6	3.1	3.1	3.0	2.9	2.8	2.8
16	2.6	2.5	2.8	3.8	4.7	4.5	3.0	3.1	3.0	2.9	2.8	2.8
17	2.5	2.5	2.8	4.0	4.7	4.4	3.0	3.3	3.0	2.8	2.8	2.8
18	2.5	2.5	2.8	4.3	4.7	4.4	3.2	3.4	3.0	2.9	2.8	2.8
19	2.5	2.5	2.9	4.2	4.8	4.3	3.4	3.5	3.0	2.9	2.8	2.8
20	2.5	2.5	2.8	4.0	4.9	4.3	3.3	3.5	3.0	2.9	2.8	2.8
21	2.5	2.5	2.8	3.9	5.4	4.2	3.2	3.4	3.0	2.9	2.8	2.8
22	2.5	2.5	2.8	3.8	5.4	4.2	3.2	3.5	3.0	2.9	2.8	2.8
23	2.5	2.5	2.9	3.7	5.5	4.1	3.0	3.4	3.0	2.9	2.8	2.8
24	2.5	2.5	2.8	3.8	5.6	4.1	3.4	3.2	3.0	2.9	2.8	......
25	2.5	2.6	2.7	3.8	5.2	4.0	3.1	3.0	3.0	2.9	2.8	......
26	2.5	3.1	2.8	3.9	5.0	3.9	3.2	3.0	3.0	2.9	2.8	......
27	2.5	3.0	3.0	4.2	5.1	3.9	3.1	3.0	3.0	2.9	2.8	......
28	2.5	2.8	3.0	4.4	5.4	3.8	3.1	3.0	3.0	2.9	2.8	......
29	2.7	......	3.1	4.4	5.4	3.8	3.1	2.9	2.9	2.9	2.8	......
30	2.9	......	2.9	4.0	5.3	3.7	3.1	2.9	2.9	2.9	2.8	......
31	2.5	......	3.0	......	5.0	......	3.1	3.7	......	2.8	......	......

NOTE.—Ice conditions during January and February. Ice jams during these months affected the gage heights.

Gage heights Dec. 24 to 31 have been suppressed, as observer read the gage wrong.

Daily discharge, in second-feet, of Price River, near Helper, Utah, for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14	8	95	95	455	1,090	311	95	1,090	72	53	45
2	14	8	72	150	455	1,150	311	95	223	53	53	53
3	14	8	53	185	507	1,400	267	95	185	72	53	53
4	14	8	53	311	671	1,530	311	95	120	72	53	53
5	14	14	53	267	787	1,590	267	95	120	72	53	53
6	14	14	37	223	846	1,660	223	95	150	72	53	53
7	14	8	53	185	966	1,660	185	120	185	72	53	53
8	14	8	37	150	1,030	1,590	150	120	150	95	52	53
9	14	8	72	150	1,090	1,460	150	120	95	72	53	24
10	14	8	53	185	1,150	1,210	150	150	95	72	53	24
11	14	8	37	223	1,210	1,090	150	150	95	72	53	24
12	14	8	37	185	1,210	1,030	120	120	95	72	53	24
13	14	8	37	185	1,030	966	120	120	95	95	53	37
14	14	14	37	311	966	966	120	120	95	72	53	53
15	14	14	24	357	906	846	120	120	95	72	53	53
16	14	14	53	405	906	787	95	120	95	72	53	53
17	14	14	53	507	906	729	95	185	95	53	53	53
18	14	14	53	671	906	729	150	223	95	72	53	53
19	14	14	72	615	966	671	223	267	95	72	53	53
20	14	14	53	507	1,030	671	185	267	95	72	53	53
21	14	14	53	455	1,340	615	150	223	95	72	53	53
22	14	14	53	405	1,340	615	150	267	95	72	53	53
23	14	14	72	357	1,400	561	95	223	95	72	53	53
24	14	14	53	405	1,460	561	223	150	95	72	53	50
25	14	14	37	405	1,210	507	120	95	95	72	53	50
26	14	14	53	455	1,090	455	150	95	95	72	53	50
27	14	25	95	615	1,150	455	120	95	95	72	53	50
28	14	40	95	729	1,340	405	120	95	95	72	53	50
29	14	......	120	729	1,340	405	120	72	72	72	53	50
30	14	......	72	507	1,280	357	120	72	72	72	53	50
31	14	......	95	......	1,090	......	120	357	......	53	......	50

NOTE.—These discharges are based on a rating curve that is well defined between 25 and 200 second-feet; fairly well defined between 200 and 800 second-feet.

Discharges estimated because of ice conditions on Jan. 6 to 14, 29, 30, Feb. 25 to 28, and Dec. 24 to 31.

Monthly discharge of Price River near Helper, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	....	....	14.0	861	D.
February	....	8	13.0	722	D.
March	120	24	59.1	3,630	A.
April	729	95	364	21,700	A.
May	1,460	455	1,030	63,300	B.
June	1,660	357	925	55,000	B.
July	311	95	167	10,300	A.
August	357	72	146	8,980	A.
September	1,090	72	142	8,450	A.
October	95	53	71.6	4,400	B.
November	53	53	53.0	3.150	B.
December	53	24	47.7	2,930	C.
The year	1,660	....	254	183,000	

SAN RAFAEL RIVER BASIN.

DESCRIPTION.

San Rafael River is formed in the western part of Emery County, crosses the central part of the county in a general southeasterly direction, and enters Green River about 16 miles below the mouth of the Price. The river has three principal branches—Ferron, Cottonwood, and Huntington creeks—which rise in the Wasatch Plateau at an altitude of about 10,000 feet above sea level. These streams fall rapidly in their upper courses and leave the plateau through almost impassable canyons cut in its eastern wall overlooking Castle Valley. They unite below Castledale, and the stream formed by their combined waters flows southeastward through the San Rafael Swell in a deep, narrow canyon, from which it emerges to flow across a low, broken country to its junction with the Green. The water of this river is derived chiefly from the melting snow on the high plateau.

SAN RAFAEL RIVER NEAR GREENRIVER, UTAH.

This station, which was established May 5, 1909, to determine the unappropriated run-off of San Rafael River, is located at the county bridge on the road from Green River to Hanksville, about 16 miles southwest of Greenriver, Utah, and about three-fourths of a mile below the Morris ranch dam. It is below all important tributaries and diversions.

The winter flow is affected by ice, and as the bed of the stream shifts somewhat frequent measurements must be made in order to get satisfactory records.

The staff gage is nailed securely to the southwest pier of the bridge, from which discharge measurements are made. The gage datum has remained unchanged since the station was established.

Discharge measurements of San Rafael River near Greenriver, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 5	E. A. Porter	47	88	2.20	223
June 9	do	100	692	7.20	3,040
20	do	102	572	6.00	2,380
Sept. 28	do	57	108	1.60	164
Nov. 23	do	60	124	1.20	178

Daily gage height, in feet, of San Rafael River near Greenriver, Utah, for 1909.

[E. F. Marshall, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	4.5	4.5	1.85	7.95	1.5	1.1	1.15
2	....	5.15	4.35	1.75	8.95	1.45	1.1	1.35
3	....	5.85	4.05	1.75	3.75	1.4	1.1	1.4
4	....	6.85	3.9	1.65	3.7	1.35	1.1	1.1
5	2.2	7.25	4.0	1.6	4.4	1.4	1.1	1.0
6	2.5	7.55	3.75	1.75	2.75	1.3	1.1	.9
7	2.8	7.85	3.65	2.15	5.45	1.3	1.1	.9
8	2.75	7.9	3.55	3.0	3.55	1.3	1.0	....
9	2.95	7.35	3.35	3.8	2.65	1.3	1.06	....
10	3.1	7.05	3.05	3.5	2.4	1.3	1.25	....
11	3.2	6.95	2.95	3.65	2.45	1.3	1.2	....
12	3.5	7.05	2.85	3.8	2.9	1.3	1.35	....
13	2.95	6.75	2.7	3.3	2.45	1.3	1.15	....
14	2.8	6.75	2.55	3.0	2.2	1.3	1.1	....
15	2.75	6.65	2.1	2.65	2.15	1.3	1.1	....
16	2.95	6.4	1.85	2.5	2.4	1.2	1.05	....
17	2.8	6.5	1.65	7.75	2.1	1.2	1.0	....
18	2.9	6.65	1.65	5.6	1.8	1.2	1.0	....
19	3.1	6.35	1.9	5.15	1.7	1.2	.9	....
20	3.55	5.9	2.4	4.75	1.65	1.2	.9	....
21	3.95	5.8	2.0	4.35	1.7	1.2	1.0	....
22	4.4	5.75	2.05	3.9	1.65	1.2	1.1	....
23	4.6	5.7	2.45	3.55	1.65	1.2	1.1	....
24	4.65	5.75	2.7	3.05	1.6	1.2	1.55	....
25	4.2	5.65	2.25	2.7	1.55	1.15	1.15	....
26	3.9	5.35	2.06	2.65	1.55	1.1	1.25	....
27	4.45	5.15	1.9	2.55	1.55	1.1	1.15	....
28	5.25	5.15	2.5	2.35	1.55	1.1	2.0	....
29	5.4	4.9	2.15	2.45	1.55	1.1	1.4	....
30	5.0	4.6	2.05	2.3	1.55	1.1	1.25	....
31	4.6	....	1.85	4.45	....	1.1	....	....

NOTE.—Ice in river in December.

Daily discharge, in second-feet, of San Rafael River near Greenriver, Utah, for 1909.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	1,090	1,310	230	3,850	140	140
2	....	1,490	1,220	220	4,720	135	140
3	....	1,990	1,030	220	820	130	140
4	....	2,760	950	190	800	125	140
5	221	3,080	1,000	180	1,150	130	140
6	290	3,320	880	220	450	120	140
7	374	3,560	830	300	1,830	130	140
8	359	3,610	780	560	730	130	130
9	423	3,160	700	880	420	130	135
10	474	2,920	580	750	350	130	170
11	510	2,930	540	810	360	130	160
12	620	3,020	510	880	500	130	185
13	423	2,780	460	670	360	130	150
14	374	2,780	420	550	300	130	140
15	359	2,800	300	430	290	130	140
16	423	2,600	230	390	330	120	150
17	374	2,680	200	3,730	260	120	140
18	406	2,800	200	2,000	190	120	140
19	474	2,650	250	1,750	180	120	130
20	640	2,300	370	1,400	170	120	130
21	816	2,230	270	1,160	180	120	140
22	1,040	2,180	280	890	170	120	160
23	1,150	2,150	380	730	170	120	160
24	1,180	2,180	460	540	160	120	240
25	938	2,110	330	430	150	115	170
26	792	1,890	280	420	150	110	185
27	1,060	1,740	250	380	150	140	170
28	1,560	1,740	390	330	150	140	360
29	1,660	1,570	300	360	150	140	210
30	1,390	1,320	280	310	150	140	185
31	1,150	....	230	1,180	....	140	....

NOTE.—Discharges May 5 to June 9 are based on a rating curve that is partly defined. For the remainder of the year the indirect method for shifting channels was used, with the above curve as standard.

Monthly discharge of San Rafael River near Greenriver, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May (5-31)	1,660	221	721	38,600	B.
June	3,610	1,090	2,450	146,000	B.
July	1,310	200	523	32,200	C.
August	3,730	180	745	45,800	C.
September	4,720	150	655	39,000	C.
October	140	110	128	7,870	C.
November	360	130	162	9,640	C.
The period	....	....	....	319,000	

COTTONWOOD CREEK NEAR ORANGEVILLE, UTAH.

This station, which was established May 1, 1909, is located at Johnson's ranch in the canyon about 5 miles northwest of Orangeville, Utah, and about 35 miles southwest of Price, the nearest railway point.

The station is below all important tributaries and above all diversions except Johnson's ditch, which takes out a small amount of water a short distance above the station.

Previous to August 22, 1909, the stage was recorded by measuring to the water surface from a reference point on a cottonwood tree 60 feet above the cable. A staff gage was installed August 22, 1909, at the same point, and all previous observations were connected to the datum of this gage. During the flood of August 31 this gage washed out. From September 1 to 17 the record was kept of the water depth at the gage site. From September 20 observations was made of the distance to water surface from a mark on a rock at the site. All gage heights for 1909 have been reduced to the datum of the staff gage.

Discharge measurements are made from a cable 60 feet below the gage site.

As the stream bed shifts, accurate determination of discharge is difficult. Heavy ice forms at this station during the winter months.

Discharge measurements of Cottonwood Creek near Orangeville, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 1	E. A. Porter	43	48	2.16	105
June 13	do	54	127	4.66	784
July 27	do	47	48.4	2.61	125
Aug. 22	do	46	41.6	2.53	89.8
Sept. 20	do	25	28	3.68	62.3
Nov. 5	do	14	15.1	3.31	31.8
Dec. 1	do	16	16.6	3.48	40.3

Daily gage height, in feet, of Cottonwood Creek near Orangeville, Utah, for 1909.

[Robert Johnson, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.15	4.75	3.95		5.3	3.6	3.4	3.5
2		5.05	3.75	2.45	3.8	3.6	3.4	3.5
3	2.45	5.55	3.65	2.45	5.2		3.3	3.5
4		5.75		2.45	4.1	3.6	3.3	3.4
5		5.75		2.45		3.5		
6	2.65		3.35	2.75	4.2	3.5	3.3	3.8
7		5.25	3.35	3.75		3.5		
8	3.05	4.95	3.25		3.8	3.5	3.3	3.8
9			3.15		3.8	3.5	3.3	3.8
10	3.15	4.75	3.15	5.45	3.6		3.3	
11	2.95	5.15		3.95	3.6	3.5	3.3	3.9
12	2.95	4.75	2.95			3.5	3.3	
13	2.85		2.95	2.45	3.8	3.5	3.3	3.8
14	2.95	4.75	2.85		3.8	3.5		
15	3.15	4.65	2.85		3.7	3.5	3.4	3.5
16		4.85		5.65	3.6	3.5	3.4	
17		5.15	2.75	5.75	3.6		3.4	4.1
18	3.15	4.55		5.75		3.5	3.6	4.0
19	3.35	4.35	2.95	5.65		3.5	3.4	
20	3.55		2.75	3.95	3.7	3.5	3.6	4.6
21	3.75	4.55	2.75	5.75	3.7	3.5		
22	4.05	4.45	2.75	2.55	3.6	3.5		4.2
23		4.65	2.75	2.5	3.6	3.5		
24	3.65	4.85		2.4	3.6			4.0
25		4.55		2.4	3.6	3.5		
26	3.95	4.15	2.65	2.4		3.5		
27	4.45		2.60	2.4	3.6	3.5		4.2
28	4.55	3.95	2.55		3.6	3.4		
29	4.65	3.65	2.55		3.6	3.4		4.0
30		4.25	2.45	3.0	3.6	3.4		
31			2.45	4.0				

NOTE.—Ice Dec. 4 to 31. Ice 4 inches thick Dec. 11; 9 inches on Dec. 18; 14 inches on Dec. 24, and 16 inches on Dec. 29.

Daily discharge, in second-feet, of Cottonwood Creek near Orangeville, Utah, for 1909.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	105	872	513	92	500	56	36	45
2	135	994	434	90	84	56	36	45
3	165	1,200	410	89	460	56	27	45
4	180	1,280	378	88	144	56	27	....
5	195	1,270	345	87	166	45	27	....
6	210	1,220	312	58	167	45	27	....
7	268	1,160	312	428	122	45	27	....
8	325	930	283	650	84	45	27	....
9	332	885	253	880	84	45	27	....
10	340	840	253	1,100	56	45	27	....
11	280	965	228	496	56	45	27	....
12	280	835	202	300	70	45	27	....
13	250	830	202	88	84	45	27	....
14	280	825	177	450	84	45	30	....
15	340	784	177	800	68	45	36	....
16	334	857	166	1,160	56	45	36	....
17	328	980	155	1,200	56	45	36	....
18	322	738	180	1,200	60	45	56	....
19	380	602	204	1,100	64	45	36	....
20	448	671	154	480	68	45	56	....
21	510	740	154	1,200	68	45	55	....
22	624	700	154	92	56	45	54	....
23	546	780	154	98	56	45	53	....
24	468	860	147	80	56	45	52	....
25	521	740	140	80	56	45	51	....
26	574	585	134	80	56	45	50	....
27	768	548	125	80	56	45	49	....
28	808	510	112	125	56	36	48	....
29	848	406	112	170	56	36	47	....
30	856	628	95	210	56	36	46	....
31	864	....	93	530	....	36	....	....

NOTE.—These discharges were obtained from rating curves applicable as follows: May 1 to Aug. 31, indirect method for shifting channels used; Sept. 1 to Dec. 3, not well defined. Discharges interpolated for days when gage was not read.

Monthly discharge of Cottonwood Creek near Orangeville, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May	....	....	416	25,600	B.
June	1,280	406	842	50,100	B.
July	513	93	218	13,400	B.
August	1,200	80	438	26,900	C.
September	500	56	104	6,190	C.
October	56	36	45.3	2,790	C.
November	....	....	38.7	2,300	C.
The period	....	....	....	127,000	

FERRON CREEK NEAR FERRON, UTAH.

This station, which was established April 28, 1909, is located near the mouth of the canyon, about 2½ miles above the town of Ferron, Utah, and is below all important tributaries.

Practically all the normal flow in the low-water season is diverted above the station by the North and South canals, only enough water passing to supply one or two small ditches that take out below.

Several gages were used during 1909, all located in the same section. All gage heights were referred to one datum until August 31, when a flood destroyed the gage and bench mark and greatly changed the section. From September 1 to December 31 all gage heights refer to a new gage which was installed September 18, 1909, at a new datum.

Discharge measurements are made from a footbridge about 10 feet above the gage. Shifting of the stream bed makes it difficult to obtain accurate discharge records. The stream is icebound during the winter.

Discharge measurements of Ferron Creek near Ferron, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 28	E. A. Fuller	20	15.5	2.10	30.6
June 12	do	31	58	4.20	496
July 26	do	17	7.6	1.40	5.7
Aug. 23	do	14	16.9	2.15	36.5
Sept. 19	do	18.5	13.3	1.75	28.4
Dec. 4	do			1.40	6.5

NOTE.—Gage heights Apr. 28 to Aug. 23 are referred to same datum. Gage heights Sept. 19 and Dec. 4 are referred to new gage installed Sept. 18, 1909.

Daily gage height, in feet, of Ferron Creek near Ferron, Utah, for 1909.

[James Westenskaw, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.3	3.75	2.65		12.0	1.8	1.6	1.5
2		2.3	4.15	2.6		1.8	1.8	1.5	1.2
3		2.5	4.55	2.85		1.8	1.8	1.5	1.1
4		2.6	4.65	2.7		1.8	1.7	1.5	1.1
5		2.65	5.05	2.6		1.8	1.6	1.5	1.5
6		2.95	4.45	2.25		1.8	1.5	1.5	1.5
7		2.95	4.26	1.95		1.8	1.4	1.5	1.5
8		2.95	3.95	2.05		1.8	1.4	1.5	1.6
9		2.75	4.20	2.05		1.8	1.4	1.5	1.8
10		2.90	4.10	2.05		1.8	1.4	1.4	2.0
11		2.75	4.05	2.05		1.8	1.6	1.4	2.0
12		2.40	4.00	1.5		1.8	1.6	1.4	2.0
13		2.3	3.65	1.5		1.8	1.6	1.4	2.0
14		2.2	3.65	1.5		1.8	1.6	1.5	2.0
15		2.3	3.65			1.8	1.6	1.6	2.0
16		2.45	3.8			1.8	1.6	1.8	2.2
17		2.45	3.75			1.8	1.6	1.8	2.3
18		2.8	3.45			1.8	1.6	1.9	2.4
19		3.05	3.45			1.8	1.6	2.1	2.8
20		3.1	3.45			1.8	1.6	2.2	2.6
21		3.2	3.5			1.8	1.6	2.2	2.6
22		3.1	3.35			1.8	1.6	1.4	2.6
23		3.1	3.5		2.15	1.8	1.6	1.8	2.5
24		2.75	3.45		2.0	1.8	1.6	1.7	2.4
25		2.9	3.4		1.9	1.8	1.6	1.6	2.0
26		3.45	3.35	1.4	1.9	1.8	1.6	1.5	2.4
27		3.5	3.05		1.9	1.8	1.6	1.4	2.6
28	2.1	3.45	2.95		1.9	1.8	1.6	1.9	2.7
29	1.8	3.15	2.95		1.8	1.8	1.6	2.0	2.6
30	1.5	3.0	2.80		1.8	1.8	1.6	1.8	2.8
31		3.3			8.0		1.6		2.8

NOTE.—After Sept, 1 gage heights referred to new datum.. Ice conditions after Nov. 13.

Daily discharge, in second-feet, of Ferron Creek near Ferron, Utah, for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	51	367	105	....	3,000	32	20
2	....	51	485	96	....	32	32	16
3	....	78	606	143	....	32	32	16
4	....	96	638	114	....	32	25	16
5	....	105	766	96	....	32	20	16
6	....	164	575	46	....	32	16	16
7	....	164	515	22	....	32	13	16
8	....	164	425	28	....	32	13	16
9	....	124	500	28	....	32	13	16
10	....	153	470	28	....	32	13	13
11	....	124	455	28	....	32	20	13
12	....	63	440	7	....	32	20	13
13	....	51	339	7	....	32	20	13
14	....	41	339	7	....	32	20	13
15	....	51	339	6	....	32	20	13
16	....	70	381	6	....	32	20	13
17	....	70	367	6	....	32	20	13
18	....	133	284	6	....	32	20	12
19	....	185	284	6	....	32	20	12
20	....	196	284	6	....	32	20	12
21	....	220	298	6	....	32	20	11
22	....	196	258	6	....	32	20	11
23	....	196	298	6	36	32	20	10
24	....	124	284	6	25	32	20	10
25	....	153	271	6	20	32	20	10
26	....	284	258	6	20	32	20	9
27	....	298	185	6	20	32	20	9
28	32	284	164	6	20	32	20	8
29	16	208	164	6	16	32	20	8
30	7	174	133	6	16	32	20	8
31	....	245	....	6	1,690	....	20	....

NOTE.—These discharges are based on rating curves applicable as follows: Apr. 28 to Aug. 31, fairly well defined below discharge of 100 second-feet. Sept. 1 to Nov. 13, not well defined. Discharge estimated, July 15 to 25, 27 to 30, and Nov. 14 to 30.

Monthly discharge of Ferron Creek near Ferron, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May	298	41	146	8,980	B.
June	766	133	372	22,100	B.
July	143	6	27.6	1,700	C.
Aug. 23-31	1,690	16	207	3,700	C.
September	3,000	32	131	7,800	D.
October	32	13	20.3	1,250	D.
November	....	....	[a] 12.7	756	D.
December	....	....	[b] 4.0	246	D.
The period	....	....	....	46,500	

[a] Partly estimated.

[b] Estimated.

HUNTINGTON CREEK NEAR HUNTINGTON, UTAH.

This station, which was established May 3, 1909, is located at Cunha's ranch, in the canyon about 6 miles northwest of Huntington, Utah, and is below all important tributaries.

The ditch for the Cunha ranch diverts a small amount of water a short distance above the station; practically all the normal low-water flow is diverted for irrigation by canals heading near Huntington. A storage reservoir above the station controls the distribution of the discharge to a considerable extent.

The vertical staff gage is in two sections. The low-water part is nailed to an old bridge abutment on the right bank about 3 feet from the cable; the high-water section is nailed to the west face of a cottonwood tree near the low-water section. Discharge measurements are made from a cable.

The gage datum has remained unchanged since the station was established.

The flow at the station is not seriously affected by ice. The shifting of the stream bed during the spring high water and summer floods impairs the reliability of the records.

Discharge measurements of Huntington Creek near Huntington, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 17	E. A. Porter	44	133	4.80	730
July 29	.....do	35	78.3	3.38	138
Aug. 21	.....do	30.5	33.3	2.65	78.8
21	.....do	32	30.1	2.75	65.5
Nov. 6	.....do	31	24.5	2.55	45.7
30[a]	.....do	31	27.6	2.65	65.3
Dec. 5[b]	.....do	31	21.9	2.51	40.4

[a] Ice 0.25 foot thick at gauge.

[b] Ice 6 inches thick at gage.

Daily gage height, in feet, of Huntington Creek near Huntington, Utah, for 1909.

[Joseph Cunha, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	4.5	3.5	3.4	5.0	....	2.5	....
2	....	4.7	3.5	3.3	4.0	2.55	2.5	....
3	3.0	5.05	3.5	3.3	3.0	2.8	2.45	....
4	3.2	5.15	3.5	3.4	3.0	2.5	2.5	....
5	3.45	5.4	3.5	3.3	2.9	2.5	2.5	....
6	3.55	5.45	3.5	3.3	2.9	2.5	2.4	2.60
7	3.7	5.25	3.5	3.4	2.9	2.5	2.4	....
8	3.85	5.1	3.4	2.9	2.8	2.5	2.5	....
9	3.9	5.0	3.4	2.8	2.8	2.5	2.5	....
10	3.85	5.0	3.4	2.8	2.8	2.5	2.45	2.7
11	4.0	5.0	3.4	2.7	2.8	2.4	2.5	....
12	3.85	5.0	3.4	2.7	2.7	2.4	2.5	....
13	3.7	4.9	3.4	2.6	2.7	2.4	2.45	....
14	3.75	4.9	3.4	2.6	2.6	2.4	2.5	2.5
15	3.8	4.9	3.3	2.6	2.6	2.4	2.5	....
16	3.7	4.7	3.3	2.5	2.6	2.4	2.4	2.6
17	3.7	4.85	3.5	2.9	2.6	2.4	2.5	....
18	3.9	4.75	3.9	2.9	2.6	2.4	2.5	....
19	4.1	4.8	3.8	2.95	2.6	2.4	2.55	2.5
20	4.25	4.65	3.7	2.95	2.5	2.4	2.5	....
21	4.4	4.7	3.7	2.95	2.5	2.35	....	....
22	4.35	4.75	3.6	2.9	2.6	2.4	....	....
23	4.3	4.6	3.5	2.8	2.6	2.4	....	2.5
24	4.35	4.6	3.5	3.0	2.7	2.5	....	....
25	4.05	4.6	3.5	2.9	2.6	2.5	2.6	....
26	4.55	4.65	3.4	2.7	2.6	2.5	....	....
27	4.55	4.45	3.4	2.8	2.7	2.45	....	2.4
28	4.55	4.45	3.4	2.9	2.6	2.45	....	....
29	4.55	4.45	3.4	2.8	2.6	2.5	....	....
30	4.3	4.45	3.4	2.8	2.6	2.45	2.7	2.5
31	4.4	....	3.4	2.8	....	2.5	....	....

NOTE.—Ice prevailed from about Nov. 20 to Dec. 31; Nov. 30, ice 3 inches thick.

Daily discharge, in second-feet, of Huntington Creek near Huntington, Utah, for 1909.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		655	225	152	800	42	42
2		732	224	134	408	74	42
3	160	875	222	160	124	38	33
4	212	914	219	163	122	38	42
5	284	920	216	147	104	38	42
6	314	1,040	213	152	103	38	29
7	362	948	210	177	102	38	31
8	412	885	183	82	85	38	42
9	430	838	180	70	84	38	42
10	412	835	178	75	82	38	35
11	468	826	175	62	80	29	39
12	412	824	173	64	66	29	38
13	362	780	170	53	64	29	32
14	378	775	168	54	53	29	38
15	392	772	144	58	52	29	38
16	362	694	143	46	51	29	32
17	362	750	189	106	50	29	41
18	430	704	308	110	49	29	41
19	503	726	268	122	48	29	45
20	560	662	238	124	38	29	41
21	615	670	235	127	37	26	
22	598	688	207	120	48	30	
23	578	622	180	128	48	30	
24	580	621	178	140	60	38	
25	484	620	175	118	52	38	
26	672	634	152	84	48	38	
27	672	556	150	98	59	33	
28	672	552	148	114	48	33	
29	672	551	147	96	48	38	
30	578	550	142	94	48	33	
31	615		147	93		38	

NOTE.—These discharges, except for the ice period, were obtained by the indirect method for shifting channels.

Monthly discharge of Huntington Creek near Huntington, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May 3-31	672	160	467	26,900	C.
June	1,040	550	741	44,100	C.
July	308	142	191	11,700	C.
August	177	46	107	6,580	C.
September	800	37	102	6,070	B.
October	74	26	35.0	2,150	B.
November	42	29	38.8	2,310	C.
December			[a] 34.8	2,140	D.
The period			215	102,000	

[a] Estimated.

NOTE.—Nov. 21 to 30 and Dec. 1 to 15, daily discharge estimated as 40 second-feet; Dec. 16 to 31, estimated as 30 second-feet, because of ice conditions.

GRAND RIVER BASIN.

DESCRIPTION.

Grand River and its tributaries drain an area comprising approximately 26,000 square miles, of which 22,290 are in Colorado and the rest in eastern Utah. On the east and southeast the basin is bounded by the high ranges of the Continental Divide, which separate it from the basins of Platte and Arkansas rivers; on the north it is limited by the White River and Book Cliffs Plateau, on the west by the canyon district of the Colorado.

Rising among the high peaks of the Rocky Mountains in the north-central portion of Colorado, the Grand flows southwestward to its junction with Green River, traversing approximately 350 miles. Its tributaries include Fraser, Blue, Eagle, Williams and Roaring forks, Gunnison and Dolores rivers, all of which enter from the south.

In most respects the Grand is a typical mountain stream, flowing throughout its course in a succession of deep canyons, whose precipitous or even perpendicular walls range in height up to 3,000 feet above the water's edge, alternating with long, narrow fertile valleys. The headwater region, comprising approximately 50 per cent of the basin, is extremely rugged, elevations ranging from 7,000 to 14,000 feet above sea level. Stream channels are numerous, tributaries are rapid, and gradients are steep, the fall ranging from 20 to 150 feet to the mile. The intermediate or middle portion of the basin—that portion immediately east and west of the Colorado State line—is a dry, broken, much-eroded region.

The rocks of the basin include all varieties, from the granites and masses of igneous origin on the crest of the Continental Divide to the younger and less resistant sedimentary rocks of the plateau region. The soils of the upper basin, though shallow, generally contain considerable organic matter; those of the intermediate basin are largely decomposed and disintegrated sedimentary rocks, which grade imperceptibly from one to the other. The scant vegetation of the lower basin renders soil erosion large.

The precipitation ranges from 5 to 10 inches in the lower basin, 10 to 20 inches in the intermediate region, and 20 to 30 inches in the headwater region. By far the greater part of the precipitation is in the form of snow.

The forestation of the mountainous part of the basin, except in a few localities, is good—the equal of any in Colorado. The forests consist of spruce, quaking asps, cedars, and piñon. The intermediate basin is fairly well forested with quaking asp, cedar, and piñon. The lower basin supports only scattered pines, cedars, and piñons, the prevailing vegetation being sagebrush, chico, and cactus pads.

The greater part of the timbered area in the Grand River basin above the Gunnison is included in the Arapahoe and Holy Cross national forests. These reserves in the Grand drainage basin include about 1,400 square miles of merchantable timberland, 900 square miles of woodland, and about 800 square miles of burned area.

In the middle basin, from the lower end of Gore Canyon to about Rifle, 30,000 to 35,000 acres will be irrigated under half a dozen small projects now contemplated. In the lower basin the Reclamation

Service has under way the Grand Valley project, to cover an irrigable area of 60,000 to 70,000 acres. Under other schemes 40,000 to 50,000 acres more will be irrigated. The Uncompahgre Valley project, which diverts water from the Gunnison, has finished structures capable of irrigating about 50,000 acres. The completed project will serve about 150,000 acres.

Natural storage within the basin is restricted to a few high mountain lakes, of which Grand Lake is the largest. There are, however, reservoirs sites along the Grand and its tributaries which if utilized would make possible a development of 1,000,000 horsepower. The Kremmling reservoir site is by far the best in the drainage basin. It is located near the upper end of Gore Canyon and with a 230-foot dam would impound about 2,200,000 acre-feet of water. A standard-gauge railroad now runs through this site.

Until recently the splendid power resources of this drainage basin have remained practically untouched. The estimated available power, including that on Dolores and Gunnison rivers, is as follows:

Minimum horsepower	540,000
Minimum horsepower (6 high months)	1,000,000
Horsepower from storage (6 months' period)	1,600,000

Of this amount less than 40,000 horsepower has so far been developed.

Hot sulphur springs are located along Grand River at two points—Hot Sulphur Springs and Glenwood Springs, Colo.—and in both localities they increase the temperature of the river water, but probably all these springs together add less than 20 second-feet to the flow of the river. The years of maximum run-off in this drainage basin were 1897 and 1907; the year of maximum run-off since records were begun was 1902.

Fraser, Eagle, Williams and Roaring forks and Gunnison River are described in connection with gaging stations now maintained. The importance of Dolores River entitles it to the following brief description, although no station is now maintained in its basin.

The Dolores rises in the La Plata and San Miguel mountains, whose highest peak, Mount Wilson, attains an elevation of over 14,000 feet. Its course is southwesterly for about 50 miles, when it turns and flows almost due north for nearly 100 miles, when it again turns to the west and enters Grand River about 15 miles west of the Colorado-Utah line. For the greater part of its course the river flows through deep canyons, and along the stream itself comparatively little irrigation is practiced. In the vicinity of Dolores, however, the valley broadens, and for about 40 miles has a width of half a mile to a mile. A considerable part of this area is cultivated. In Paradox Valley also considerable land is cultivated, chiefly from small tributaries running into the main stream. By far the greater part of the Dolores River water is used for irrigation in the San Juan drainage basin, to which it is diverted by means of a tunnel and a great cut into the Montezuma Valley.

San Miguel River, the most important tributary of the Dolores, which drains an area immediately west of the headwaters of the Uncompahgre River, rises in San Miguel County, Colo., and enters the Dolores about 12 miles east of the Colorado-Utah line at an elevation of about 5,000 feet. In general the stream and its tributaries flow northeasterly. Considerable land along the San Miguel is irrigated.

The mean annual run-off of Dolores River above the mouth of the San Miguel is nearly 400,000 acre-feet, and the San Miguel furnishes at least half that amount.

Probably 600 square miles of the Dolores River basin is covered with merchantable timber and as much more is woodland. The total area of this basin is about 4,500 square miles.

The basin contains several small storage reservoir sites, a few of which have been developed, both for power and irrigation. Theoretically, by utilizing storage it would be possible to develop from 75,000 to 100,000 horsepower in the Dolores drainage basin. The river has an average fall of over 20 feet per mile throughout almost its whole course, and a great stretch of the San Miguel has an average fall of more than 50 feet to the mile. Several water-power plants are in operation along the upper San Miguel and its tributaries, the development aggregating nearly 10,000 horsepower, of which about 7,500 horsepower is developed at the Ames, Howard Fork, and Illium plants of the Telluride Power Co. One plant on Bridal Veil Creek is utilizing a head of 2,000 feet to develop 1,200 horsepower.

NORTH FORK OF GRAND RIVER NEAR GRAND LAKE, COLO.

This station, which was established July 29, 1904, is located at the highway bridge on the road between Grand Lake and Grandby, and is about 3 miles southwest of Grand Lake post office, Colo., and about 2 miles above Grand Lake Outlet, which is the most important tributary of this fork of the Grand. The nearest railroad is the Denver, Northwestern & Pacific, at Granby, Colo., distant about 12 miles.

One large ditch above the station diverts water into the headwaters of the Cache la Poudre, in the South Platte drainage basin.

Winter records at this station are more satisfactory than at the other stations on the headwaters of the Grand, as near-by springs tend to keep the stream at the gaging station more or less open.

The location and datum of the staff gage, which is at the bridge, have remained unchanged during the maintenance of the station.

Fairly good results have been obtained at this station, though low-stage measurements, because of sluggish current, are not entirely satisfactory.

The station was discontinued September 30, 1909.

Discharge measurements of North Fork of Grand River near Grand Lake, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 3 [a]	C. L. Chatfield	40	59	3.60	45
Aug. 9 [b]	W. B. Freeman	44	42	3.97	88

[a] Channel practically open. [b] Made by wading at different sections.

Daily gage height, in feet, of North Fork of Grand River near Grand Lake, Colo., for 1909.

[Harry W. Carr, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1		3.35	3.3	3.35		4.7	5.7	4.15	3.9
2	3.35					4.8	5.8	4.15	3.9
3	3.35	3.3	3.35	3.35		5.0	5.8	4.1	3.85
4				3.35		5.25	6.1	4.05	3.85
5	3.35	3.3	3.35			5.35	6.1	4.05	3.85
6				3.35	4.1	5.8	5.8	4.0	3.85
7	3.35	3.3	3.35			5.8	5.6	4.0	3.85
8				3.35		5.8	5.5	4.0	4.2
9	3.35	3.35	3.35		4.25	5.8	5.4	3.95	4.15
10			3.4	3.35		5.7	5.0	3.95	4.0
11		3.35		3.35		5.5	4.8	3.95	3.95
12	4.0		3.4			5.45	4.8	4.0	3.9
13		3.3		3.35		5.45	4.7	4.0	3.8
14	3.4		3.35		4.5	5.5	4.65	3.95	3.8
15		3.3		3.35	4.45	5.5	4.6	3.9	3.8
16	3.35		3.35	3.4	4.6	5.5	4.55	4.0	3.8
17	3.35	3.35			4.5	5.8	4.5	4.1	3.8
18	3.35		3.35	3.4	4.65	6.1	4.5	4.4	3.8
19		3.35			4.8	6.5	4.5	4.1	3.8
20	3.3		3.35	3.35	5.0	6.6	4.5	4.0	3.75
21		3.35	3.35		5.1	6.2	4.5	3.95	3.75
22	3.35			3.35	5.0	6.1	4.45	3.9	3.75
23	3.35	3.3	3.35		5.0	6.1	4.45	3.9	3.7
24				3.4	4.85	6.2	4.6	3.85	3.7
25	3.35	3.3	3.55		4.7	6.1	4.4	3.85	3.7
26				3.4	4.6	6.1	4.35	3.85	3.7
27	3.6	3.35	3.3		4.65	5.9	4.3	3.85	3.65
28		3.4	3.3	3.6	4.75	5.9	4.2	3.8	3.65
29	3.6			3.6	5.0	5.7	4.2	3.8	3.65
30			3.35	3.7	4.75	5.7	4.15	3.8	3.65
31	3.4				4.5		4.15	3.9	

NOTE.—Slight ice conditions from Jan. 1 to Apr. 26. Ice affected gage heights on Jan. 12, 27, and 29.

Daily discharge, in second-feet, of North Fork of Grand River near Grand Lake, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	15	15	12	15	65	347	902	145	85
2	15	14	14	15	80	390	970	145	85
3	15	12	15	15	90	479	970	130	77
4	15	12	15	15	105	611	1,190	118	77
5	15	12	15	15	120	671	1,190	118	77
6	15	12	15	15	130	970	970	105	77
7	15	12	15	15	145	970	834	105	77
8	15	14	15	15	161	970	767	105	160
9	15	15	15	15	177	970	702	95	145
10	16	15	19	15	195	902	479	95	105
11	17	15	19	15	213	767	390	95	95
12	18	14	19	15	231	734	390	105	85
13	19	12	17	15	249	734	347	105	69
14	19	12	15	15	267	767	326	95	69
15	17	12	15	15	248	767	306	85	69
16	15	14	15	19	306	767	286	105	69
17	15	15	15	19	267	970	267	130	69
18	15	15	15	19	326	1,190	467	230	69
19	14	15	15	17	390	1,530	267	130	69
20	12	15	15	15	479	1,620	267	105	62
21	14	15	15	15	528	1,270	267	95	62
22	15	14	15	15	479	1,190	248	85	62
23	15	12	15	17	479	1,190	248	85	55
24	15	12	22	19	412	1,270	306	77	55
25	15	12	30	19	347	1,190	230	77	55
26	15	14	21	19	306	1,190	212	77	55
27	15	15	12	31	326	1,040	194	77	49
28	15	19	12	43	368	1,040	160	69	49
29	17	....	14	43	479	902	160	69	49
30	17	....	15	55	368	902	145	69	49
31	19	....	15	....	347	....	145	85	....

NOTE.—These discharges are based on rating curves applicable as follows:

Jan. 1 to Apr. 26, an ice curve, not defined; Apr. 28 to Sept. 30, well defined below 1,000 second-feet.

Discharges for days on which gage was not read estimated. Discharges for Jan. 12, 27, and 29 estimated because of serious ice conditions.

Monthly discharge of North Fork of Grand River near Grand Lake, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	19	12	15.6	909	D.
February	19	12	13.7	761	D.
March	30	12	16.0	984	C.
April	55	15	19.7	1,170	C.
May	528	65	280	17,200	B.
June	1,620	347	944	56,200	A.
July	1,190	145	465	28,600	A.
August	230	69	104	6,400	B.
September	160	49	74.3	4,420	B.
The period				117,000	

GRAND RIVER NEAR GRANBY, COLO.

This station, which was established June 19, 1908, is located at a highway bridge that crosses the river about 4 miles from Granby on the road to Grand Lake.

The station is about 4 miles below the junction of North and South forks, about the same distance above the mouth of Fraser River, and is above the mouth of Willow Creek. The drainage area is about 500 square miles.

No important diversions are made on the South Fork or on the main stream above the station. This basin affords some excellent storage sites. Several filings for power development have been made above this station, but additional opportunities for filing no doubt exist. A small power plant is located on a tributary of the South Fork.

Measurements of discharge are made from a cable 300 feet downstream from the bridge.

Thick ice covers the river for about four months each year and anchor ice also occurs.

The location and datum of the gage have remained unchanged during the maintenance of the station.

Discharge measurements of Grand River near Granby, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 10[a]	C. L. Chatfield	25	30	2.40	33
May 4	do	95	145	2.10	259
7	do	98	153	2.55	386
8	do	100	144	2.46	343
June 17	do	111	411	4.65	2,590
Aug. 9	W. B. Freeman	90	170	2.41	366
Oct. 14	R. H. Woolsey	85	104	1.67	122

[a] Ice conditions.

Daily gage height, in feet, of Grand River near Granby, Colo., for 1909.

[J. P. Switzer, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.25	2.5	2.5	2.9	1.8	3.15	5.05	2.55	2.2	1.7	1.35	1.3
2	2.2	2.5	2.35	2.9	1.8	3.2	4.95	2.55	2.25	1.7	1.35	1.3
3	2.15	2.5	2.5	2.95	1.85	3.4	5.05	2.55	2.20	1.7	1.35	1.3
4	2.25	2.5	2.8	2.9	2.05	3.7	4.95	2.5	2.20	1.7	1.35	1.3
5	2.25	2.5	2.6	2.9	2.30	4.2	4.70	2.4	2.15	1.7	1.35	1.3
6	2.4	2.4	2.7	2.6	2.5	4.5	4.55	2.45	2.2	1.7	1.35	1.3
7	2.35	2.35	3.05	2.8	2.55	4.75	4.25	2.45	2.55	1.7	1.35	1.3
8	2.45	2.4	2.55	2.6	2.65	4.85	4.15	2.5	2.55	1.6	1.35	1.3
9	2.5	2.4	2.6	2.8	2.6	4.8	4.05	2.4	2.5	1.6	1.35	1.3
10	2.5	2.4	2.85	2.85	2.6	4.6	3.95	2.45	2.45	1.6	1.35	1.3
11	2.45	2.35	2.85	2.75	2.75	4.4	3.75	2.4	2.35	1.6	1.35	1.3
12	2.45	2.4	2.8	2.65	2.8	4.3	3.6	2.55	2.3	1.6	1.35	1.3
13	2.5	2.4	2.7	2.7	2.85	4.35	3.55	2.6	2.35	1.6	1.4	1.3
14	2.5	2.4	2.6	2.85	2.75	4.3	3.35	2.55	2.3	1.6	1.4	1.75
15	2.5	2.35	2.8	2.9	2.8	4.3	3.3	2.5	2.2	1.6	1.4	1.8
16	2.5	2.4	2.85	2.9	2.8	4.35	3.3	2.6	2.1	1.6	1.4	1.9
17	2.55	2.45	2.95	3.1	2.9	4.55	3.25	2.55	2.05	1.6	1.4	1.85
18	2.5	2.45	3.15	3.0	2.95	4.9	3.2	2.8	2.0	1.6	1.4	1.55
19	2.5	2.3	3.05	2.95	3.05	5.3	3.2	2.65	2.0	1.6	1.4	1.85
20	2.55	2.6	3.05	2.6	3.3	5.45	3.2	2.55	2.0	1.5	1.4	1.85
21	2.5	2.65	3.05	1.55	3.4	5.05	3.2	2.55	1.9	1.5	1.4	1.8
22	2.5	2.95	3.1	1.4	3.55	5.05	3.1	2.5	1.8	1.5	1.4	1.8
23	2.5	2.7	3.05	1.65	3.7	5.05	3.0	2.45	1.8	1.5	1.4	1.8
24	2.45	2.7	2.95	1.55	3.5	5.05	3.1	2.35	1.8	1.5	1.4	1.8
25	2.55	2.6	2.95	1.55	3.3	5.15	3.05	2.3	1.8	1.45	1.4	1.8
26	2.65	2.55	2.95	1.65	3.1	4.95	3.05	2.3	1.7	1.45	1.4	1.8
27	2.65	2.45	3.05	1.7	3.0	5.0	3.05	2.2	1.7	1.45	1.4	1.8
28	2.7	2.5	3.05	1.75	3.1	4.95	2.85	2.2	1.7	1.45	1.4	1.75
29	2.6	....	3.15	1.85	3.45	4.75	2.75	2.2	1.7	1.4	1.4	1.7
30	2.6	....	3.05	1.9	3.25	5.05	2.7	2.2	1.7	1.4	1.4	1.8
31	2.6	....	3.05	....	3.1	....	2.55	2.2	....	1.4	....	1.8

NOTE.—Ice conditions from Jan. 1 to Apr. 20 and from Dec. 14 to 31.

Daily discharge, in second-feet, of Grand River near Granby, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	157	802	3,250	430	280	132	62	54
2	....	157	840	3,070	430	298	132	62	54
3	....	170	1,000	3,250	430	280	132	62	54
4	....	230	1,290	3,070	405	280	132	62	54
5	....	317	1,870	2,630	359	263	132	62	54
6	....	405	2,310	2,390	382	280	132	62	54
7	....	430	2,720	1,940	382	430	132	62	54
8	....	482	2,890	1,800	405	430	109	62	54
9	....	455	2,800	1,680	359	405	109	62	54
10	....	455	2,470	1,560	382	382	109	62	54
11	....	540	2,160	1,340	359	338	109	62	54
12	....	570	2,010	1,190	430	317	109	62	54
13	....	600	2,080	1,140	455	338	109	70	54
14	....	540	2,010	962	430	317	109	70	....
15	....	570	2,010	920	405	280	109	70	....
16	....	570	2,080	920	455	246	109	70	....
17	....	630	2,390	880	430	230	109	70	....
18	....	662	2,980	840	570	214	109	70	....
19	....	730	3,720	840	482	214	109	70	....
20	....	920	4,000	840	430	214	88	70	....
21	98	1,000	3,250	840	430	184	88	70	....
22	70	1,140	3,250	765	405	157	88	70	....
23	120	1,290	3,250	695	382	157	88	70	....
24	98	1,100	3,250	765	338	157	88	70	....
25	98	920	3,440	730	317	157	79	70	....
26	120	765	3,070	730	317	132	79	70	....
27	132	695	3,160	730	280	132	79	70	....
28	144	765	3,070	600	280	132	79	70	....
29	170	1,050	2,720	540	280	132	70	70	....
30	184	880	3,250	510	280	132	70	70	....
31	....	765	....	430	280	....	70	....	....

NOTE.—These discharges are based on a rating curve that is well defined.

Daily discharges from Jan. 1 to Apr. 20 probably average from 33 to 50 second-feet. Mean discharge from Dec. 14 to 31 estimated as 40 second-feet.

Monthly discharge of Grand River near Granby, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May	1,290	157	644	39,600	B.
June	4,000	802	2,540	151,000	B.
July	3,250	430	1,350	83,000	A.
August	570	280	387	23,800	A.
September	430	132	250	14,900	A.
October	132	70	103	6,330	B.
November	70	62	67	3,990	B.
December	....	....	45.9	2,820	C.
The period	....	....	....	325,000	

GRAND RIVER AT SULPHUR SPRINGS, COLO.

This station was originally established July 27, 1904, at the highway bridge one-eighth mile below Sulphur Springs. On April 17, 1906, it was moved to a new highway bridge, about 1,000 feet above the old location, and a standard chain gage was installed. This gage has no determined relation to the old gage. The station was discontinued September 30, 1909. The data obtained are used to check up the results at other stations on Grand River and its tributaries and to afford a basis for estimating the flow of some of the smaller tributaries.

The Grand is joined by Fraser River about 10 miles above Sulphur Springs and by Williams Fork a few miles below. The drainage area at the station is about 950 square miles.

A number of small private ditches divert water for meadow irrigation along the principal tributaries above the station and along the Grand. A number of large diversion ditches are located in the lower drainage basin. Filings for power development are numerous from source to mouth, but it is probable that a large amount of this water would still be available for appropriation for irrigation.

The river at the station freezes across for about four months each year, the ice sometimes reaching a depth of 2 feet. No artificial control is used.

On account of unfavorable measuring conditions during the winter months at the regular section, temporary gages have been maintained in a canyon one-fourth mile below, where the river is open and where measurements can be made by wading. A temporary gage was used from January 25 to March 17, 1908, and another, 200 feet nearer the regular station, from November 25 to December 20, 1908. From April 1 to 16, 1908, an old staff gage was read by the observer instead of the chain gage. Gage heights for this period were adjusted to refer to the chain-gage datum. Beginning December 22, 1908, readings were resumed at the chain gage by measuring through a hole cut in the ice.

The accuracy of the results obtained at the old location of the station was affected to a certain extent by a bend in the river above the station, by the bridge pier, and by ice.

Discharge measurements of Grand River at Sulphur Springs, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 10[a]	C. L. Chatfield	56	72	[b] 2.55	102
Apr. 29	.....do	103	194	2.40	543
May 8	.....do	83	278	3.20	1,080
June 17[c]	.....do	303	902	6.17	5,140
Aug. 8	.....do	110	226	2.70	608

[a] Made by wading in mouth of canyon.
[b] Gage height distorted by ice conditions.
[c] Stay line used.

Daily gage height, in feet, of Grand River at Sulphur Springs, Colo., for 1909.

[E. L. Chatfield, jr., observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.6	2.8	2.7	2.6	2.15	4.2	6.3	3.2	2.6
2	2.55	2.75	2.7	2.3	2.2	4.3	6.3	3.2	2.6
3	2.6	2.75	2.75	2.45	2.3	4.7	6.2	3.1	2.6
4	2.6	2.75	2.7	2.45	2.45	5.2	6.1	3.05	2.6
5	2.6	2.7	2.7	2.2	2.5	5.5	6.15	3.0	2.5
6	2.65	2.7	2.65	2.4	3.1	5.9	6.0	2.9	2.5
7	2.6	2.8	2.65	2.35	3.05	6.5	5.7	2.8	2.5
8	2.55	2.8	2.65	2.25	2.95	6.6	5.35	2.8	2.5
9	2.55	2.75	2.7	2.3	3.0	6.65	5.05	2.65	2.5
10	2.6	2.8	2.65	2.25	3.4	6.6	4.85	2.7	2.4
11	2.65	2.75	2.6	2.1	3.55	6.35	4.8	2.8	2.4
12	2.75	2.75	2.6	2.0	3.6	6.2	4.75	2.9	2.5
13	3.0	2.75	2.6	1.9	3.4	6.0	4.8	2.9	2.4
14	3.05	2.8	2.6	1.95	3.4	5.8	4.85	2.9	2.4
15	3.1	2.8	2.65	2.0	3.4	5.55	3.75	2.85	2.35
16	3.1	2.75	2.65	2.0	3.4	5.55	3.7	2.95	2.4
17	3.1	2.75	2.65	2.1	3.5	6.25	3.65	3.05	2.4
18	3.1	2.75	2.65	2.1	3.7	6.35	3.65	3.2	2.4
19	3.05	2.75	2.7	2.05	3.9	6.45	3.7	3.3	2.35
20	3.05	2.8	2.75	2.2	4.2	6.45	3.6	3.2	2.4
21	3.05	2.8	2.8	2.2	4.55	6.6	3.65	3.1	2.35
22	3.05	2.75	2.9	2.2	4.55	6.5	3.6	3.0	2.3
23	3.0	2.8	3.0	2.35	4.7	6.3	3.6	2.8	2.2
24	3.0	2.8	3.0	2.35	4.8	6.35	3.55	2.7	2.25
25	2.9	2.75	3.05	2.5	4.55	6.55	3.45	2.6	2.25
26	2.9	2.75	2.95	2.5	4.0	6.9	3.4	2.6	2.2
27	2.9	2.7	2.9	2.7	3.9	6.65	3.4	2.6	2.2
28	2.9	2.7	2.75	2.7	4.1	6.5	3.4	2.65	2.2
29	2.85	....	2.7	2.5	4.7	6.2	3.4	2.45	2.2
30	2.8	....	2.65	2.6	4.4	6.25	3.3	2.45	2.3
31	2.8	....	2.65	....	4.3	....	3.3	2.7	....

NOTE.—Ice conditions from Jan. 1 to Apr. 1.

Daily discharge, in second-feet, of Grand River at Sulphur Springs, Colo., for 1909.

May.	Apr.	May.	June.	July.	Aug.	Sept.	May.	Apr.	May.	June.	July.	Aug.	Sept.
1	[a]485	401	2,100	5,350	980	555	16	320	1,260	4,090	1,530	780	445
2	485	429	1,230	5,350	935	555	17	373	1,340	5,260	1,470	850	445
3	573	485	2,780	5,180	890	555	18	373	1,530	5,440	1,460	960	445
4	573	573	3,530	5,010	850	555	19	346	1,740	5,610	1,500	1,040	418
5	429	603	4,010	5,100	810	500	20	429	2,100	5,610	1,390	960	445
6	543	1,020	4.670	4,840	745	500	21	429	2,570	5.880	1,430	885	418
7	514	978	5,700	4,330	680	500	22	429	2,570	5,700	1,370	815	390
8	457	902	5.880	3.770	680	500	23	514	2,780	5.350	1,360	680	340
9	485	940	5.970	3.300	585	500	24	514	2,930	5.440	1,310	615	365
10	457	1,260	5,880	3,000	615	445	25	603	2,570	5,790	1,220	555	365
11	373	1,380	5.440	2.930	680	445	26	603	1.860	6,420	1,170	555	340
12	320	1,430	5.180	2.860	745	500	27	729	1,740	5,970	1,170	555	340
13	271	1,260	4,840	2,930	745	445	28	729	1,980	5,700	1,160	585	340
14	296	1,260	4,500	3.000	745	445	29	603	2,780	5,180	1,150	472	340
15	320	1,260	4,090	1,580	712	418	30	665	2,360	5,260	1,070	472	390
							31	......	1,230	......	1,060	615	......

[a] Estimated.

NOTE.—These discharges are based on rating curves applicable as follows: Apr. 2 to July 14, fairly well defined; July 15 to Aug. 5, indirect method for shifting channels used; Aug. 6 to Sept. 30, fairly well defined.

Monthly discharge of Grand River at Sulphur Springs, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April	729	271	475	28,300	A.
May	2,930	401	1,530	94,100	A.
June	6,420	1,230	4,950	295,000	A.
July	5,350	1,060	2,560	157,000	B.
August	1,040	472	735	45,200	A.
September	555	340	441	26,200	A.
The period				646,000	

GRAND RIVER NEAR KREMMLING, COLO.

This station, which was established July 24, 1904, is located at the upper end of Gore Canyon, about 3 miles southwest of Kremmling, Colo., near the Kremmling reservoir dam site, which is the largest in Colorado.

The records obtained at this station show the water available for storage and power development and are used also to estimate probable run-off of some of the smaller tributaries between Kremmling and Sulphur Springs.

Blue River, the largest tributary above this station, empties into the Grand about 2 miles above. Other important tributaries between Kremmling and Sulphur Springs are Williams Fork and Troublesome and Muddy rivers.

A number of private ditches divert water for meadow irrigation from both the main stream and its tributaries between Sulphur Springs and this station.

The river is frozen completely across at the station for about four months each year. During this period the records are affected by the surface ice and also by anchor ice forming in the riffle just below the gage.

On October 18, 1906, the present slope gage was established on the opposite side of the river from the old chain gage. The zero of the slope gage is about 0.70 foot above the zero of the old gage. Measurements of discharge are made from a cable a few feet downstream from the gage.

Scouring during high stages and silting during low stages affect the accuracy of results. Data obtained are good at high and medium stages, but at low stages are not so accurate.

Discharge measurements of Grand River near Kremmling, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage. height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 12[a]	C. L. Chatfield	100	138	0.80	260
Apr. 29[b]	.....do	115	658	4.20	1,320
May 10	.....do	133	1,250	8.00	3,290
June 18	.....do	160	3,090	16.22	[c]13,000
19	.....do	160	3,180	16.90	[c]13,800
Aug. 7	W. B. Freeman	121	1,240	5.20	1,840
Oct. 10	R. H. Woolsey	105	549	2.50	749
Nov. 23	.....do	103	305	1.80	609

[a] Made through the ice.
[b] Some floating ice in river.
[c] Subsurface velocity method used. Coefficient taken as 95 per cent.

Daily gage height, in feet, of Grand River near Kremmling, Colo., for 1909.

[H. A. Howe, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.05	0.75	1.1	1.4	3.35	9.85	14.8	5.25	5.25	2.8	1.5	1.5
2	1.05	.9	1.15	1.45	3.15	9.95	14.65	5.25	5.1	2.75	1.55	1.55
3	.9	.95	1.15	2.3	3.05	10.65	14.6	5.25	4.55	2.7	1.8	1.1
4	.75	.95	1.05	2.05	4.1	12.0	14.85	5.0	4.35	2.7	1.9	1.15
5	.8	1.3	1.0	1.95	5.65	13.5	15.15	4.8	4.35	2.6	1.7	.65
6	.85	1.3	1.0	1.7	6.65	14.95	14.65	4.65	4.8	2.65	1.6	.8
7	.9	1.25	.95	1.4	7.4	16.0	13.35	5.1	5.75	2.65	1.6	1.1
8	.9	1.2	.9	1.4	7.15	16.8	12.1	4.95	6.05	2.85	1.4	1.1
9	.9	1.2	.85	1.4	7.25	17.2	11.4	5.9	5.5	2.7	1.3	1.4
10	.8	1.1	.75	1.6	7.9	16.95	10.9	5.4	5.15	2.65	1.65	1.35
11	.8	1.0	.8	1.6	8.5	16.3	10.1	5.45	4.8	2.65	1.5	1.45
12	.9	1.1	.8	1.55	8.95	15.55	9.5	5.75	4.35	2.55	1.7	1.3
13	.9	1.15	.8	1.85	8.35	15.05	8.95	5.85	4.35	2.5	1.5	1.05
14	.9	1.3	.8	1.7	8.05	15.05	8.55	5.6	4.35	2.5	1.3	1.3
15	1.0	1.2	.8	2.15	8.05	14.9	8.25	5.1	4.2	2.5	1.3	1.25
16	1.05	1.15	.85	3.2	8.35	14.6	8.0	5.1	4.15	2.4	1.4	.95
17	1.05	1.15	.9	4.35	8.4	14.85	7.6	5.0	4.0	2.3	1.3	.95
18	.85	1.1	.9	4.65	8.8	15.8	7.45	7.4	3.9	2.3	.9	.9
19	.8	1.05	.9	3.35	9.2	16.95	7.5	7.45	3.85	2.25	1.15	1.0
20	.8	1.0	.85	3.25	10.0	18.0	7.6	6.2	3.6	2.2	1.75	1.3
21	.8	1.0	.9	2.85	10.8	18.0	7.7	5.6	3.45	2.1	1.95	1.8
22	.8	.9	.9	2.35	11.15	17.2	7.2	5.4	3.5	1.95	1.95	2.15
23	.9	1.0	1.0	2.25	11.65	16.7	7.3	4.95	3.5	2.0	1.8	2.1
24	.8	1.0	1.05	2.7	11.6	16.45	7.75	4.9	3.4	1.85	2.1	2.05
25	.8	1.0	1.1	2.7	10.9	16.65	8.1	5.05	3.3	1.7	1.8	2.4
26	.75	1.05	1.0	3.4	9.7	16.55	7.15	4.7	3.3	1.75	1.75	2.35
27	.8	1.1	1.25	4.0	9.5	16.0	6.9	4.25	3.15	1.8	1.65	2.45
28	.7	1.1	1.4	4.7	10.15	15.6	6.6	4.2	3.0	1.75	1.35	2.45
29	.7	....	1.0	4.85	10.75	15.15	6.05	4.3	2.9	1.75	1.45	2.5
30	.7	....	1.05	4.05	11.2	14.9	5.8	4.15	2.85	1.65	1.45	2.6
31	.6	....	1.4	....	10.0	....	5.55	4.7	....	1.55	....	2.2

NOTE.—Ice conditions from Jan. 1 to Mar. 31 and from Dec. 20 to 31.

Daily discharge, in second-feet, of Grand River near Kremmling, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	490	1,080	4,960	11,000	1,860	1,860	890	515	515
2	502	1,010	5,050	10,800	1,860	1,800	875	528	528
3	740	978	5,740	10,700	1,860	1,550	860	590	415
4	665	1,360	7,280	11,000	1,750	1,460	860	620	428
5	535	2,060	9,220	11,500	1,660	1,460	830	565	302
6	565	2,620	11,200	10,800	1,590	1,660	845	540	340
7	490	3,080	12,600	9.020	1,800	2,120	845	540	415
8	490	2,920	13,700	7,400	1,730	2,280	908	490	415
9	490	2,990	14,200	6,570	2,200	1,990	860	465	490
10	540	3,410	13,900	6,010	1,940	1,820	845	552	478
11	540	3,840	13,000	5,190	1,960	1,660	845	515	502
12	528	4,180	12,000	4,640	2,120	1,460	815	565	465
13	605	3,720	11,300	4,180	2,170	1,460	800	515	402
14	565	3.510	11,300	3,870	2,040	1,460	800	465	465
15	695	3,510	11,100	3,650	1,800	1,400	800	465	452
16	1,030	3,720	10,700	3,480	1,800	1,380	770	490	378
17	1,460	3,760	11,000	3,220	1,750	1,320	740	465	378
18	1,590	4,060	12,300	3,120	3,080	1,280	740	365	365
19	1,080	4,380	13,900	3,150	3,120	1,260	725	428	390
20	1,050	5,100	15,300	3,220	2,360	1,170	710	578	465
21	908	5,960	15,300	3,280	2,040	1,120	680	635	450
22	755	6,280	14.200	2,960	1,940	1,140	635	635	450
23	725	6.850	13.500	3.020	1,730	1,140	650	590	450
24	860	6,800	13,200	3,310	1,700	1,100	605	680	450
25	860	6,010	13,500	3,540	1,770	1,060	565	590	450
26	1,100	4,820	13,300	2,920	1,620	1,060	578	578	450
27	1,320	4,640	12,600	2,760	1,420	1,010	590	552	450
28	1,620	5.240	12,100	2,580	1,400	960	578	478	450
29	1,680	5,850	11,500	2,280	1,440	925	578	502	450
30	1,340	6,340	11,100	2,140	1,380	908	552	502	450
31	....	5,100	....	2,020	1,620	....	528	....	450

NOTE.—These discharges are based on a rating curve that is well defined above 500 second-feet. Daily discharge for ice period from Dec. 20 to 31, estimated.

Monthly discharge of Grand River near Kremmling, Colo., for 1909.

[Drainage area, 2,380 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
April	1,680	490	864	0.363	0.40	51,400	B.
May	6,860	978	4,040	1.70	1.96	248,000	A.
June	15,300	4,960	11,700	4.92	5.49	696,000	A.
July	11,500	2,020	5,270	2.21	2.55	324,000	A.
August	3,120	1,380	1,890	.794	.92	116,000	A.
September	2,280	908	1,410	.592	.66	83,900	A.
October	908	528	739	.311	.36	45,400	A.
November	680	365	533	.224	.25	31,700	A.
December	515	302	437	.184	.21	27,000	B.
The period	....	....	....	....	....	1,620,000	

GRAND RIVER AT GLENWOOD SPRINGS, COLO.

This station, which is located at Glenwood Springs, was established May 12, 1899, discontinued July 17, and reestablished January 7, 1900. The position and datum of the gage have remained unchanged. A float gage is placed on the right bank of the river about one-fourth of a mile above the State bridge. Discharge measurements are made from a cable underneath this bridge.

This may be considered a base station, as the records show the entire run-off of the basin above the mouth of Roaring Fork. Ice never forms at this station, as the hot water from the near-by springs keeps the water above the freezing point even in the most severe weather. The winter records are, therefore, of especial value, as they furnish a basis for estimating approximately the discharge of the streams at other stations in the basin during the ice period.

The station is about one-fourth mile above Roaring Fork, which is the third largest tributary of the Grand.

A few minor irrigation ditches are taken out between this and the Kremmling station, but do not affect the discharge to any appreciable extent. The Shoshone plant of the Central Colorado Power Co., having a head of 170 feet, was practically completed in 1908. The tail water from this plant is returned to the river above the gaging station.

Results at this station are satisfactory. The channel has always been permanent except during 1907 and 1908, when the débris from the Shoshone plant was deposited in the river bed, thereby changing the rating curve of the stream.

Discharge measurements of Grand River at Glenwood Springs, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 13	C. L. Chatfield	180	407	3.78	628
Mar. 16	.....do	185	464	4.04	788
Apr. 20	.....do	195	710	5.28	1,920
June 21[a]	Chatfield and Matthes	190	2,230	12.00	27,300
30	W. B. Freeman	222	1,900	9.45	18,500
July 13	W. H. Snelson, jr	220	1,300	7.12	7,530
24	W. B. Freeman	210	1,080	6.50	5,050
Aug. 5	W. H. Snelson, jr	205	843	5.10	2,640
Oct. 9	G. H. Russell	190	649	4.20	1,630

[a] Measurement from foot bridge a few feet upstream from the cable section.

Daily gage height, in feet, of Grand River at Glenwood Springs, Colo., for 1909.

[W. H. Richardson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sepr.	Oct.	Nov.	Dec.
1	3.9	3.7	3.75	4.3	5.5	7.4	9.35	5.35	5.15	4.3	3.75	3.6
2	3.9	3.7	3.8	4.3	5.3	7.3	9.25	5.3	5.25	4.2	3.7	3.65
3	3.9	3.7	3.9	4.4	5.2	7.65	9.2	5.25	5.1	4.25	3.7	3.7
4	3.9	3.8	3.95	4.5	5.2	8.35	9.2	5.2	5.0	4.2	3.8	3.5
5	3.95	3.9	4.35	4.5	5.7	9.3	9.35	5.1	4.95	4.2	3.8	3.15
6	4.4	3.9	4.2	4.6	6.3	10.0	9.1	5.05	5.0	4.2	3.8	3.1
7	4.3	3.9	4.2	4.45	6.5	10.8	8.6	5.1	5.25	4.15	3.8	3.2
8	4.25	3.9	4.15	4.2	6.7	10.95	8.4	5.15	5.6	4.3	3.8	3.05
9	4.15	3.9	4.1	4.2	6.6	11.2	8.0	5.1	5.5	4.2	3.7	3.35
10	4.2	3.9	4.05	4.2	6.75	11.2	7.8	5.5	5.3	4.2	3.7	3.6
11	4.1	3.9	4.0	4.2	7.0	10.75	7.45	5.3	5.1	4.15	3.75	3.4
12	3.8	4.0	3.9	4.4	7.0	10.25	7.2	5.35	5.1	4.2	3.8	3.4
13	3.8	4.0	3.9	4.4	7.0	10.4	7.1	5.45	4.95	4.1	3.8	3.4
14	3.9	4.0	3.9	4.3	6.9	10.4	6.9	5.45	4.95	4.1	3.8	3.4
15	4.35	4.0	4.0	4.3	6.9	10.3	6.8	5.3	4.9	4.1	3.6	3.35
16	4.25	3.9	4.0	4.6	6.95	10.1	6.7	5.15	4.9	4.1	3.6	3.2
17	4.1	3.95	4.1	5.0	7.0	10.25	6.6	5.15	4.85	4.05	3.4	3.15
18	4.05	3.95	4.15	5.5	7.0	10.7	6.5	5.6	4.85	4.0	3.4	3.05
19	4.05	3.95	4.15	5.7	7.25	11.3	6.5	6.1	4.7	4.0	3.5	2.9
20	4.1	3.85	4.2	5.5	7.5	11.85	6.55	6.05	4.75	4.0	3.7	2.9
21	4.1	3.85	4.25	5.3	7.7	12.0	6.5	5.55	4.7	4.0	3.8	2.9
22	4.1	3.8	4.25	5.1	8.0	11.65	6.5	5.4	4.6	4.0	3.85	3.2
23	4.3	3.8	4.4	5.0	8.3	11.3	6.4	5.2	4.55	3.9	3.8	3.25
24	4.05	3.75	4.3	4.9	8.3	10.65	6.55	5.05	4.5	3.9	3.85	3.3
25	3.9	3.8	4.3	4.95	8.0	10.55	6.7	5.15	4.5	3.9	3.8	3.3
26	3.9	3.8	4.3	5.05	7.5	10.4	6.55	5.1	4.45	3.9	3.8	3.25
27	3.8	3.7	4.3	5.3	7.5	10.25	6.25	4.9	4.4	3.75	3.7	3.3
28	3.85	3.7	4.35	5.6	7.7	9.9	5.95	4.9	4.4	3.85	3.7	3.4
29	3.7	......	4.4	5.8	8.05	9.6	5.7	4.9	4.35	3.85	3.6	3.3
30	3.65	......	4.4	5.75	8.2	9.5	5.6	4.9	4.35	3.8	3.6	3.3
31	3.6	......	4.3	......	7.7	......	5.45	4.95	......	3.8	......	3.35

Daily discharge, in second-feet, of Grand River at Glenwood Springs, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	690	575	602	980	2,440	7,500	18,100	2,970	2,800	1,750	1,140	1,000
2	690	575	630	980	2,150	7,250	17,400	2,890	2,970	1,630	1,090	1,040
3	690	575	690	1,070	2,010	8,470	17,000	2,820	2,730	1,690	1,090	1,090
4	690	630	720	1,170	2,010	11,300	17,000	2,740	2,580	1,630	1,190	920
5	720	690	1,020	1,170	2,750	17,600	18,100	2,590	2,500	1,630	1,190	672
6	1,070	690	900	1,270	3,810	22,600	16,300	2,520	2,580	1,630	1,190	640
7	980	690	900	1,120	4,220	28,300	13,200	2,590	3,020	1,570	1,190	705
8	940	690	860	900	4,650	29,400	12,100	2,670	3,660	1,750	1,190	610
9	860	690	820	900	4,430	31,200	10,200	2,590	3,470	1,630	1,090	810
10	900	690	785	900	4,760	31,200	9,380	3,240	3,100	1,630	1,090	1,000
11	820	690	750	900	5,360	28,000	8,080	2,900	2,780	1,570	1,140	845
12	630	750	690	1,070	5,360	24,400	7,260	2,290	2,780	1,630	1,190	845
13	630	750	690	1,070	5,360	25,400	6,960	3,150	2,550	1,510	1,190	845
14	690	750	690	980	5,120	25,400	6,390	3,210	2,550	1,510	1,190	845
15	1,020	750	750	980	5,120	24,700	6,110	2,960	2,530	1,510	1,000	810
16	940	690	750	1,270	5,240	23,300	5,840	2,720	2,530	1,510	1,000	706
17	820	720	820	1,740	5,360	24,400	5,580	2,720	2,450	1,460	845	672
18	785	720	860	2,440	5,360	27,600	5,330	3,500	2,450	1,400	845	610
19	785	720	860	2,750	6,000	32,000	5,330	4,520	2,250	1,400	920	520
20	820	660	900	2,440	6,710	36,100	5,460	4,400	2,310	1,400	1,090	520
21	820	660	940	2,150	7,000	37,200	5,330	3,390	2,250	1,400	1,190	520
22	820	630	940	1,870	8,100	34,600	5,330	3,180	2,100	1,400	1,240	705
23	980	630	1,070	1,740	9,350	32,000	5,090	2,850	2,070	1,290	1,190	740
24	785	602	980	1,610	9,500	27,200	5,460	2,610	2,000	1,290	1,240	775
25	690	630	980	1,680	8,500	26,500	5,840	2,760	2,000	1,290	1,190	775
26	690	630	980	1,800	7,000	25,400	5,460	2,700	1,940	1,290	1,190	740
27	630	575	980	2,150	7,150	24,400	4,750	2,400	1,870	1,140	1,090	775
28	660	575	1,020	2,590	7,900	21,900	4,100	2,400	1,870	1,240	1,090	845
29	575	......	1,070	2,910	9,350	19,800	3,590	2,410	1,800	1,240	1,000	775
30	550	......	1,070	2,830	10,200	19,100	3,400	2,420	1,800	1,190	1,000	775
31	525	......	980	......	8,350	......	3,140	2,500	......	1,190	......	810

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to May 20, not well defined; May 21 to June 5 and Aug. 6 to Sept. 30, indirect method for shifting channels used; June 6 to Aug. 5, fairly well defined above discharge of 3,200 second-feet; Oct. 1 to Dec. 31, not well defined.

Monthly discharge of Grand River at Glenwood Springs, Colo., for 1909.

[Drainage area, 4,520 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	1,070	525	771	0.171	0.20	47,400	A.
February	750	575	665	.147	.15	36,900	A.
March	1,070	602	861	.190	.22	52,900	A.
April	2,910	900	1,580	.350	.39	94,000	B.
May	10,200	2,010	5,830	1.29	1.49	358,000	B.
June	37,200	7,250	24,500	5.42	6.05	1,460,000	C.
July	18,100	3,140	8,470	1.87	2.16	521,000	B.
August	4,520	2,400	2,910	.644	.74	179,000	B.
September	3,660	1,800	2,480	.549	.61	148,000	B.
October	1,750	1,140	1,460	.323	.37	89,800	B.
November	1,240	845	1,110	.246	.27	66,000	B.
December	1,090	520	772	.171	.20	47,500	C.
The year	37,200	520	4,280	.948	12.85	3,100,000	

GRAND RIVER NEAR PALISADES, COLO.[1]

This station was established April 9, 1902, at a steel highway bridge 2 miles above Palisades, Colo., at a point where the river enters Grand Valley.

The station is below all important tributaries except Gunnison and Dolores rivers, and is above all the irrigating ditches supplying water for irrigation in Grand Valley, excepting a ditch for one pumping plant which diverts about 80 second-feet for irrigation one-fourth mile above the gage. The proposed high-line canal of the United States Reclamation Service will take its water about 7 miles above Palisades.

The gage has been permanently located at the highway bridge above Palisades and no change in datum has occurred. The original wire gage was replaced by a chain gage on April 5, 1904. The river usually freezes over a portion of the year, but except for the interference of slush ice and an occasional thin ice cover the winter records are good.

Measuring conditions at the gage are poor, especially at high water. Beginning September 27, 1905, the measurements were made from a suspension bridge in the town of Palisades. Measurements are now made from the new steel bridge opened in the spring of 1909. The measuring conditions at both of these bridges are about the same. The sections are permanent, but at flood stages the velocities are high and the interference of bridge piers vitiates the results somewhat. Flood measurements prior to 1906 made at the upper bridge where the gage is located are less reliable than those made at the lower bridges.

---

[1] Called "at Palisades" in Water-Supply Paper 249.

Discharge measurements of Grand River near Palisades, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 6	S. O. Harper	315	1,530	15.65	7,750
8	....do	321	1,850	16.45	9,690
11	D. L. Henderson	325	2,130	17.40	11,800
19[a]	....do	366	2,180	17.65	14,100
22[a]	S. O. Harper	381	2,560	18.75	18,300
June 1[a]	D. L. Henderson	370	2,240	18.05	15,400
5[a]	....do	390	3,030	20.15	26,600
8[a]	S. O. Harper	400	3,860	22.05	37,500
11[a]	D. L. Henderson	380	4,150	22.35	35,600
21[a]	....do	380	4,390	23.15	44,800
29[a]	Freeman, Harper, and Henderson	383	3,820	21.45	29,300
July 28[a]	D. L. Henderson	330	1,820	15.70	7,300
Aug. 5[a]	....do	300	1,410	14.40	3,950
Sept. 9	S. O. Harper	254	612	12.50	1,740
Oct. 13	G. H. Russell	300	1,020	13.45	2,810

[a] Subsurface velocity method used. Coefficients used, from 8 to 87 per cent.

Daily gage height, in feet, of Grand River near Palisades, Colo., for 1909.

[J. J. Morrow and Alex. Gowdey, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14.7	13.15	12.05	12.45	14.35	18.1	20.95	14.85	14.4	13.6	12.9	12.9
2	14.3	13.1	12.3	12.45	14.1	17.85	20.65	14.65	14.75	13.55	12.9	12.8
3	14.4	13.1	12.45	12.55	14.0	18.25	20.65	14.7	14.65	13.5	12.9	12.95
4	14.45	13.1	12.8	12.7	14.1	19.2	20.85	14.6	14.5	13.4	12.9	12.75
5	14.45	13.1	13.1	12.95	14.7	20.35	20.8	14.4	14.8	13.4	12.9	12.7
6	14.25	13.1	13.05	12.9	15.75	21.5	20.65	14.3	15.25	13.4	12.9	12.7
7	13.9	12.95	13.05	12.65	16.2	22.05	20.25	14.3	15.2	13.5	12.9	12.6
8	13.85	12.85	12.55	12.55	16.5	22.65	19.4	14.4	15.6	13.5	14.9	12.6
9	13.4	12.7	12.3	12.4	16.6	22.7	18.95	14.45	15.65	13.6	12.9	12.6
10	13.45	12.7	12.3	12.4	16.8	22.55	18.3	14.7	15.2	13.55	12.9	12.6
11	13.2	12.4	12.25	12.45	17.4	22.2	17.95	14.75	15.0	13.4	12.9	12.6
12	13.2	12.35	12.15	12.55	17.5	21.85	17.6	14.75	15.1	13.4	12.9	12.6
13	12.7	12.55	12.15	12.55	17.5	21.75	17.35	14.75	14.85	13.45	12.9	12.6
14	13.1	12.25	12.35	12.55	17.15	21.65	16.9	14.8	14.8	13.45	12.9	12.6
15	13.5	12.2	12.4	12.55	16.95	21.5	16.7	14.65	14.65	13.3	12.9	12.5
16	13.8	12.15	12.45	12.75	16.95	21.4	16.65	14.5	14.5	13.35	12.9	12.5
17	13.9	12.25	12.55	13.2	17.0	21.6	16.5	14.6	14.55	13.3	12.9	12.5
18	13.0	12.2	12.55	13.85	17.3	21.8	16.2	14.8	14.5	13.3	12.9	12.5
19	13.2	12.2	12.55	14.7	17.85	22.55	16.1	15.5	14.4	13.25	12.9	12.5
20	13.15	12.2	12.6	14.9	18.3	23.15	16.2	15.55	14.25	13.05	12.9	12.5
21	13.05	12.15	12.6	14.2	18.55	23.05	16.1	15.6	14.15	13.15	12.9	12.5
22	14.45	12.1	12.5	13.85	18.95	23.05	15.95	15.1	14.0	13.2	13.0	12.5
23	13.55	12.1	12.6	13.55	19.15	22.65	15.85	14.8	13.95	13.15	13.0	12.5
24	12.6	12.1	12.65	13.45	19.3	22.5	16.05	14.6	13.9	13.1	13.0	12.5
25	12.25	12.05	12.5	13.4	18.95	22.3	16.3	14.55	13.9	13.0	13.0	12.5
26	12.15	12.05	12.45	13.6	18.55	22.2	16.2	14.55	13.8	13.0	13.3	12.5
27	12.15	12.05	12.5	14.05	18.5	21.8	16.0	14.4	13.8	13.0	13.3	12.5
28	12.15	12.05	12.5	14.4	18.8	21.8	15.7	14.25	13.75	13.0	13.0	12.5
29	12.1	....	12.55	14.65	19.3	21.2	15.5	14.1	13.7	13.0	13.05	12.5
30	12.15	....	12.6	14.5	19.1	20.9	15.25	14.25	13.6	13.0	13.05	12.5
31	12.7	....	12.6	....	18.6	....	14.95	14.5	....	13.0	....	12.5

NOTE.—Ice conditions from Jan. 1 to 24 and Jan. 31 to Feb. 15.

Daily discharge, in second-feet, of Grand River near Palisades, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,200	1,200	1,120	1,480	4,500	15,600	29,300	5,570	4,600	3,070	2,010	2,010
2	1,200	1,200	1,320	1,480	3,990	14,600	27,700	5,130	5,350	2,980	2,010	1,880
3	1,200	1,200	1,480	1,580	3,800	16,200	27,700	5,240	5,130	2,900	2,010	2,080
4	1,300	1,200	1,880	1,760	3,990	20,300	28,800	5,020	4,810	2,730	2,010	1,820
5	1,300	1,200	2,280	2,080	5,240	26,000	28,500	4,600	5,460	2,730	2,010	1,760
6	1,500	1,200	2,210	2,010	7,660	32,500	27,700	4,390	6,460	2,730	2,010	1,760
7	1,500	1,200	2,210	1,700	8,880	35,800	25,500	4,390	6,350	2,900	2,010	1,640
8	1,500	1,200	1,580	1,580	9,810	39,700	21,300	4,600	7,290	2,900	2,010	1,640
9	1,500	1,200	1,320	1,420	10,100	40,000	19,200	4,700	7,410	3,070	2,010	1,640
10	1,500	1,200	1,320	1,420	10,800	39,000	16,400	5,240	6,350	2,980	2,010	1,640
11	1,400	1,250	1,280	1,480	12,900	36,800	15,000	5,350	5,900	2,730	2,010	1,640
12	1,200	1,250	1,190	1,580	13,200	34,600	13,600	5,350	6,120	2,730	2,010	1,640
13	1,300	1,250	1,190	1,580	13,200	34,000	12,700	5,350	5,570	2,820	2,010	1,640
14	1,400	1,250	1,370	1,580	12,000	33,400	11,100	5,460	5,460	2,820	2,010	1,640
15	1,500	1,200	1,420	1,580	11,300	32,500	10,400	5,130	5,130	2,570	2,010	1,530
16	1,450	1,190	1,480	1,820	11,300	31,900	10,300	4,810	4,810	2,650	2,010	1,530
17	1,400	1,280	1,580	2,420	11,400	33,100	9,810	5,020	4,920	2,570	2,010	1,530
18	1,400	1,230	1,580	3,520	12,500	34,300	8,880	5,460	4,810	2,570	2,010	1,530
19	1,400	1,230	1,580	5,240	14,600	39,000	8,590	7,050	4,600	2,500	2,010	1,530
20	1,400	1,230	1,640	5,680	16,400	43,000	8,880	7,170	4,290	2,210	2,010	1,530
21	1,400	1,190	1,640	4,190	17,400	42,300	8,590	7,290	4,090	2,350	2,010	1,530
22	1,400	1,150	1,530	3,520	19,200	42,300	8,180	6,120	3,800	2,420	2,140	1,530
23	1,400	1,150	1,640	2,980	20,100	39,700	7,910	5,460	3,700	2,350	2,140	1,530
24	1,300	1,150	1,700	2,820	20,800	38,700	8,450	5,020	3,610	2,280	2,140	1,530
25	1,280	1,120	1,530	2,730	19,200	37,400	9,180	4,920	3,610	2,140	2,140	1,530
26	1,190	1,120	1,480	3,070	17,400	36,800	8,880	4,920	3,430	2,140	2,570	1,530
27	1,190	1,120	1,530	3,900	17,200	34,300	8,310	4,600	3,430	2,140	2,570	1,530
28	1,190	1,120	1,530	4,600	18,500	34,300	7,530	4,290	3,340	2,140	2,140	1,530
29	1,150	....	1,580	5,130	20,800	30,700	7,050	3,990	3,250	2,140	2,210	1,530
30	1,190	....	1,640	4,820	19,900	29,000	6,460	4,290	3,070	2,140	2,210	1,530
31	1,200	....	1,640	....	17,600	....	5,790	4,810	....	2,140	....	1,530

NOTE.—These discharges, except for the ice periods, are based on a rating curve that is well defined above 1,200 second-feet.

Daily discharges Jan. 1 to 24 and Jan. 31 to Feb. 15 estimated from a general comparison with Grand and Roaring Fork at Glenwood Springs, considering also the open-water periods of January and February.

Monthly discharge of Grand River near Palisades, Colo., for 1909.

[Drainage area, 8,550 square miles.]

Month.	Discharge in second-feet.				Run-off.		
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	Accuracy.
January	....	....	1,340	0.157	0.18	82,400	D.
February	....	....	1,200	.140	.15	66,600	D.
March	2,280	1,120	1,560	.182	.21	95,900	C.
April	5,680	1,420	2,690	.315	.35	160,000	C.
May	20,800	3,800	13,100	1.53	1.76	806,000	B.
June	43,000	14,600	33,300	3.89	4.34	1,980,000	B.
July	29,300	5,790	14,400	1.68	1.94	885,000	B.
August	7,290	3,990	5,190	.607	.70	319,000	B.
September	7,410	3,070	4,870	.570	.64	290,000	B.
October	3,070	2,140	2,570	.301	.35	158,000	A.
November	2,570	2,010	2,080	.243	.27	124,000	B.
December	2,080	1,530	1,630	.191	.22	100,000	C.
The year	....	....	7,000	.817	11.11	5,100,000	

NORTH INLET TO GRAND LAKE AT GRAND LAKE, COLO.

Two streams, known as the North and East Inlets, flow into Grand Lake, North Inlet being the larger.

The gaging station on the North Inlet, which was established August 3, 1905, is located at the footbridge which crosses the stream about 100 yards north of the mouth and 300 yards east of the Grand Lake post office.

The approximate elevation of this basin is 8,000 to 11,000 feet above sea level, and the fall of the stream is very great.

No important tributaries enter above the station, which therefore gives results for the whole drainage area, measuring 36.5 square miles.

No water is diverted above the station, but filings have already been made for power development.

The stream is covered with thick ice for about four months, and winter gage readings are therefore of little value.

No change has been made in the datum of the staff gage at the bridge during the maintenance of the station.

The accuracy of the records is affected by the roughness of the stream bed and by ice. The records are fragmentary, as the gage has not been read continuously. No gage records were obtained in 1909.

The station was discontinued September 30, 1909.

Discharge measurements of North Inlet to Grand Lake at Grand Lake, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 3[a]	C. L. Chatfield	14	6.4	3.00	8.5
Aug. 10[b]	W. B. Freeman	50	....	2.51	69.

[a] Ice at station. Measurement made by wading 100 feet below footbridge.

[b] Made by wading about 30 feet upstream from gauge.

GRAND LAKE OUTLET AT GRAND LAKE, COLO.

This station, which was established July 31, 1904, and discontinued September 30, 1909, is located at a footbridge at the west end of Grand Lake, about half a mile south of Grand Lake post office, Colo., in sec. 6, T. 3 N., R. 75 W. Granby, about 15 miles distant, on the Denver, Northwestern & Pacific Railroad, is the nearest railroad point.

The records of the station show the available storage of Grand Lake and the total run-off from the North and East inlets, and are valuable for use in connection with power development. The drainage area at the station is 62 square miles.

Shore ice forms at the station for about four months, but the stream does not freeze over because of the higher temperature of the water coming out of Grand Lake.

The location and datum of the staff gage at the footbridge have remained unchanged during the maintenance of the station. Measurements have been taken at various stations, more usually at a ford one-fourth mile downstream from footbridge, where a tag wire has been stretched across the stream 50 feet above the ford.

During low stages the rough bottom and sluggish character of the stream affect the accuracy of the results to a considerable extent.

Discharge measurements of Grand Lake Outlet at Grand Lake, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 3[a]	C. L. Chatfield	17	12	1.60	20
Aug. 10[b]	W. B. Freeman	95	118	2.20	120

[a] Measurement made by wading. Not at regular section.
[b] Measurement made by wading at regular section.

Daily gage height, in feet, of Grand Lake Outlet at Grand Lake, Colo., for 1909.

[M. Wescott, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.35	1.4	1.3	1.35	1.5	2.4	4.3	2.35	2.1
2	1.35	1.4	1.3	1.35	1.55	2.4	4.3	2.3	2.1
3	1.35	1.4	1.3	1.35	1.55	2.55	4.3	2.3	2.05
4	1.35	1.4	1.3	1.35	1.55	3.0	4.25	2.3	2.05
5	1.35	1.4	1.3	1.35	1.6	3.4	4.45	2.25	2.05
6	1.35	1.35	1.3	1.35	1.7	3.8	4.1	2.2	2.05
7	1.4	1.35	1.3	1.35	1.8	3.9	3.85	2.2	2.1
8	1.4	1.35	1.3	1.35	1.85	4.05	3.7	2.2	2.35
9	1.4	1.35	1.3	1.35	1.9	4.0	3.5	2.2	2.4
10	1.4	1.35	1.25	1.35	2.0	3.9	3.4	2.2	2.3
11	1.35	1.35	1.25	1.35	2.0	3.75	3.3	2.3	2.2
12	1.35	1.35	1.25	1.35	2.05	3.5	3.2	2.3	2.1
13	1.35	1.35	1.25	1.35	2.05	3.5	3.1	2.35	2.1
14	1.35	1.35	1.25	1.35	2.05	3.6	2.95	2.35	2.05
15	1.4	1.4	1.25	1.35	2.05	3.6	2.9	2.3	2.05
16	1.4	1.4	1.25	1.35	2.0	3.7	2.8	2.2	2.05
17	1.4	1.4	1.25	1.4	2.0	3.95	2.8	2.2	2.0
18	1.4	1.4	1.25	1.4	2.1	4.3	2.8	2.4	1.95
19	1.4	1.4	1.25	1.45	2.2	4.6	2.8	2.4	1.95
20	1.4	1.4	1.25	1.45	2.4	4.6	2.8	2.3	1.9
21	1.4	1.4	1.25	1.45	2.65	4.25	2.8	2.2	1.85
22	1.45	1.35	1.25	1.45	2.8	4.2	2.8	2.2	1.85
23	1.45	1.35	1.3	1.45	2.8	4.15	2.75	2.1	1.85
24	1.45	1.35	1.35	1.45	2.8	4.3	2.8	2.2	1.8
25	1.45	1.35	1.35	1.45	2.6	4.4	2.8	2.2	1.8
26	1.45	1.35	1.35	1.45	2.45	4.25	2.75	2.2	1.8
27	1.45	1.35	1.35	1.45	2.4	4.3	2.7	2.1	1.75
28	1.4	1.35	1.35	1.5	2.4	4.2	2.6	2.1	1.75
29	1.4	....	1.35	1.5	2.6	4.3	2.5	2.1	1.75
30	1.4	....	1.35	1.5	2.6	4.2	2.45	2.05	1.75
31	1.4	....	1.35	....	2.5	....	2.4	2.05	....

NOTE.—Although Grand Lake was frozen over it is probable that the above gage heights during the winter months are not materially affected by ice.

Daily discharge, in second-feet, of Grand Lake Outlet at Grand Lake, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9	11	7.5	9	16	170	1,050	156	97
2	9	11	7.5	9	19	170	1,050	143	97
3	9	11	7.5	9	19	214	1,050	143	87
4	9	11	7.5	9	19	372	1,020	143	87
5	9	11	7.5	9	22	550	1,140	131	87
6	9	9	7.5	9	32	762	931	119	87
7	11	9	7.5	9	44	818	790	119	97
8	11	9	7.5	9	52	902	706	119	156
9	11	9	7.5	9	60	874	600	119	170
10	11	9	6.0	9	77	818	550	119	143
11	9	9	6.0	9	77	734	502	143	119
12	9	9	6.0	9	87	600	456	143	97
13	9	9	6.0	9	87	600	413	156	97
14	9	9	6.0	9	87	652	352	156	87
15	11	11	6.0	9	87	652	333	143	87
16	11	11	6.0	9	77	706	297	119	87
17	11	11	6.0	11	77	846	297	119	77
18	11	11	6.0	11	97	1,050	297	170	68
19	11	11	6.0	13	119	1,220	297	170	68
20	11	11	6.0	13	170	1,220	297	143	60
21	11	11	6.0	13	246	1,020	297	119	52
22	13	9	6.0	13	297	989	297	119	52
23	13	9	7.5	13	297	960	280	97	52
24	13	9	9	13	297	1,050	297	119	44
25	13	9	9	13	230	1,100	297	119	44
26	13	9	9	13	184	1,020	280	119	44
27	13	9	9	13	170	1,050	263	97	38
28	11	9	9	16	170	989	230	97	38
29	11	....	9	16	230	1,050	199	97	38
30	11	....	9	16	230	989	184	87	38
31	11	....	9	....	199	....	170	87	....

NOTE.—These discharges are based on a rating curve that is well defined below a discharge of 400 second-feet.

Monthly discharge of Grand Lake Outlet at Grand Lake, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	13	9	10.7	658	B.
February	11	9	9.86	548	B.
March	9	6	7.26	446	B.
April	16	9	11.0	655	B.
May	297	16	92.7	5,700	A.
June	1.220	170	805	47,900	A.
July	1,140	170	491	30,200	A.
August	156	87	127	7,810	A.
September	170	38	79.8	4,750	A.
The period	....	....	....	98,000	

SOUTH FORK OF GRAND RIVER NEAR LEHMAN, COLO.

This station is located at a footbridge near Lehman's ranch house, about a mile above the junction with the North Fork and about 2 miles from Lehman post office, Colo.

From September 25, 1907, to June 10, 1908, the records of the flow at this station were kept by the Central Colorado Power Co. The engineer in charge of the work used, in general, United States Geological Survey methods, but the results furnished by the company for publication have not been verified by engineers of the survey.

The drainage area at the station is about 79 square miles. The vertical staff gage is located at the footbridge.

Practically no water is diverted above the station other than that used for meadow irrigation.

Discharge measurements of South Fork of Grand River near Lehman, Colo., 1907–8.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
1907.					
Sept. 11	R. I. Meeker	58	88	4.30	47
Oct. 16	C. L. Chatfield	45	42	4.16	25
Nov. 21	R. I. Meeker	22	23	4.02	20
Dec. 10	.....do	13	10.2	3.93	9.8
1908.					
Jan. 14	R. I. Meeker	23	25.2	3.76	8.7
Feb. 21[a]	C. L. Chatfield	28.5	15.8	4.08	8.4
Mar. 17	.....do	27	17	4.00	9.2
Apr. 16	.....do	68	62	4.65	90
May 20	.....do	79	12.5	5.40	258
Sept. 16	.....do	45	49	4.33	44
Oct. 21	.....do	44	42	4.15	18
Nov. 24[b]	.....do	35	22	4.05	12.7
Dec. 20[a]	.....do	24	16.8	4.15	10.9

[a] Made through ice. [b] Frozen at gage. Ice 1.5 feet thick.

NOTE.—Measurements in 1908 made by wading at various sections.

Daily gage height, in feet, of South Fork of Grand River near Lehman, Colo., for 1907–8.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1907.					1907.					1907.				
1	......	4.3	4.1	3.95	11	......	4.35	4.1	3.95	21	......	4.25	4.05	4.1
2	......	4.25	4.1	4.0	12	......	4.3	4.1	4.0	22	......	4.2	4.05	4.1
3	......	4.25	4.0	4.0	13	......	4.2	4.2	4.0	23	......	4.2	4.05	4.1
4	......	4.25	4.15	3.95	14	......	4.3	4.3	4.0	24	......	4.2	4.0	4.1
5	......	4.25	4.1	3.95	15	......	4.25	4.35	4.0	25	4.25	4.15	4.1	4.1
6	......	4.20	4.1	4.0	16	......	4.25	4.3	4.0	26	4.25	4.15	4.0	4.1
7	......	4.35	4.1	4.0	17	......	4.2	4.3	4.0	27	4.25	4.1	4.05	4.1
8	......	4.45	4.1	4.0	18	......	4.2	4.3	4.0	28	4.25	4.15	4.0	4.1
9	......	4.4	4.05	4.0	19	......	4.2	4.1	4.1	29	4.20	4.15	4.0	4.1
10	......	4.35	4.0	4.0	20	......	4.1	4.1	4.1	30	4.25	4.15	3.95	4.1
										31	......	4.15	......	4.1

[Ed. W. Lehman, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1908.							1908.						
1	4.1	4.10	4.00	4.00	4.35	5.00	16	4.3	4.00	4.00	4.65	4.55	......
2	4.1	4.10	4.00	4.00	4.40	5.02	17	4.3	4.00	4.00	4.70	4.82	......
3	4.2	4.10	4.00	4.00	4.52	5.25	18	4.2	4.10	4.00	4.65	4.95	......
4	4.2	4.10	4.00	4.02	4.60	5.60	19	4.2	4.10	4.00	4.60	5.05	......
5	4.2	4.10	4.00	4.08	4.52	5.60	20	4.2	4.10	4.05	4.60	5.38	......
6	4.2	4.10	4.00	4.05	4.50	5.55	21	4.2	4.10	4.00	4.65	5.02	......
7	4.2	4.10	4.00	4.05	4.50	5.40	22	4.2	4.08	4.00	4.75	4.82	......
8	4.2	4.10	4.00	4.10	4.62	5.25	23	4.2	4.00	4.00	4.90	4.78	......
9	4.2	4.10	4.00	4.10	4.82	5.25	24	4.2	4.08	4.00	4.78	4.85	......
10	4.3	4.10	4.00	4.10	4.78	5.65	25	4.2	4.02	4.05	4.62	4.95	......
11	4.3	4.00	4.00	4.10	4.65	......	26	4.2	4.00	4.05	4.50	4.88	......
12	4.3	4.00	4.00	4.18	4.60	......	27	4.2	4.05	4.02	4.48	4.80	......
13	4.3	4.00	4.00	4.08	4.58	......	28	4.2	4.00	4.00	4.42	4.75	......
14	4.3	4.00	4.00	4.22	4.52	......	29	4.2	4.00	4.00	4.35	4.68	......
15	4.3	4.00	4.00	4.55	4.52	......	30	4.2	......	4.00	4.32	4.70	......
							31	4.2	......	4.00	......	4.72	......

NOTE.—Ice conditions from Jan. 1 to Mar. 10, 1908.

Daily discharge, in second-feet, of South Fork of Grand River near Lehman, Colo., for 1907–8.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1907.					1907.					1907.				
1	......	47	22	10	11	......	55	22	10	21	......	40	17.5	9
2	......	40	22	13.5	12	......	47	22	10	22	......	33	17.5	9
3	......	40	13.5	13.5	13	......	33	33	10	23	......	33	17.5	9
4	......	40	27.5	10	14	......	47	47	10	24	......	33	13.5	9
5	......	40	22	10	15	......	40	55	10	25	40	28	22	9
6	......	33	22	13.5	16	......	40	47	10	26	40	28	13.5	9
7	......	55	22	13.5	17	......	33	47	10	27	40	22	17.5	9
8	......	73	22	13.5	18	......	33	47	10	28	40	28	13.5	9
9	......	64	17.5	13.5	19	......	33	22	10	29	33	28	13.5	9
10	......	55	13.5	13.5	20	......	22	22	10	30	40	28	10	9
										31	......	28	......	9

Day.	Mar.	Apr.	May.	June.	Day.	Mar.	Apr.	May.	June.	Day.	Mar.	Apr.	May.	June.
1908.					1908.					1908.				
1	......	9	44	161	11	9	16	91	......	21	9	91	166	......
2	......	9	50	166	12	9	24	82	......	22	9	109	122	......
3	......	9	69	220	13	9	14	79	......	23	9	138	115	......
4	......	10	82	313	14	9	28	69	......	24	9	115	128	......
5	......	14	69	313	15	9	74	69	......	25	12	86	150	......
6	......	12	66	299	16	9	91	74	......	26	12	66	134	......
7	......	12	66	259	17	9	100	122	......	27	10	62	118	......
8	......	16	86	220	18	9	91	150	......	28	9	54	109	......
9	......	16	122	220	19	9	82	172	......	29	9	44	96	......
10	9	16	115	327	20	12	82	254	......	30	9	40	100	......
										31	9	......	104	......

NOTE.—These discharges are based on rating curves furnished by the Central Colorado Power Co. applicable as follows: Sept. 25 to Dec. 31, 1907, and Mar. 10 to June 11, 1908. The daily discharges have been changed slightly to conform to the computation rules used by the United States Geological Survey.

Monthly discharge of South Fork of Grand River near Lehman, Colo., for 1907–8.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
Sept. 25–30	40	33	38.8	462
October	73	22	38.6	2,370
November	55	10	24.3	1,450
December	14	9	10.5	646
1908.				
January	9	8.5	8.7	535
February	8.5	8.5	8.5	489
March	12	8.5	9.5	584
April	138	9	51	3,150
May	254	44	106	6,490
June 1–10	327	161	250	4,960

NOTE.—The values have been changed slightly to conform to the computation rules used by the United States Geological Survey.

FRASER RIVER BASIN.

FRASER RIVER AT GRANBY, COLO.

Fraser River rises among the peaks of the Front Range in southeastern Grand County and flows in a general northwesterly direction to its junction with Grand River in the east-central part of Middle Park.

The station, which was established July 28, 1904, to obtain data for use in determining the availability of the stream for power, storage, and irrigation, is located at the wagon bridge three-quarters of a mile southwest of Granby, about 4 miles above the mouth of Fraser River, in sec. 9, T. 1 N., R. 76 W., and is below all tributaries. The station was discontinued September 30, 1909.

The drainage area is about 220 square miles.

Other than small irrigation ditches, there are no important diversions above the station. A small canal is taken out a few feet downstream from the measuring section. It is proposed to divert water by means of a tunnel from the headwaters of this river into the headwaters of South Boulder Creek, in the Platte drainage basin.

Thick ice covers the stream during about four months of the year; anchor ice also occurs. Each year in the low-water season a small temporary dam is generally constructed about 50 feet below the station to divert the water up on the gage, thus affecting the conditions of free flow. It was taken out May 5, 1909.

Neither the location or the datum of the staff gage at the highway bridge was changed during the maintenance of the station.

Measuring conditions are rather poor. During high stages the flow is affected by backwater and a boiling effect caused by the crib piers of the bridge. During low stages ice and the temporary diversion dam interfere with good results.

Discharge measurements of Fraser River at Granby, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 9[a]	C. L. Chatfield	44	29	5.08	44
Apr. 28[b]	.....do	45	61	5.30	226
May 6	.....do	69	148	5.54	462
June 16	Chatfield, Matthes, and Snelson	61	218	6.35	1,060
Aug. 11	Freeman and Woolsey	56	125	5.15	267

[a] Made by wading 250 feet above gage; 3.5 feet of ice at gage.
[b] Made by wading 200 feet above pumping station opposite Granby.

NOTE.—Measurements beginning May 6 were made after the temporary dam was removed.

Daily gage height, in feet, of Fraser River at Granby, Colo., for 1909.

[J. N. Ostrander, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	5.5	5.0	5.1	5.1	4.95	5.7	6.8	5.1	5.0
2	5.7	4.95	5.1	5.1	4.85	5.7	6.8	5.1	5.0
3	5.7	4.95	5.1	5.1	4.95	5.85	6.8	5.1	5.0
4	5.6	5.0	5.1	5.25	5.1	6.0	6.7	5.1	5.0
5	5.6	5.1	5.1	5.1	5.6	6.35	6.55	5.1	5.1
6	5.6	5.1	5.1	5.0	5.55	6.5	6.45	5.1	5.1
7	5.6	5.1	5.3	4.9	5.4	6.6	6.35	5.1	5.1
8	5.6	5.1	5.4	4.9	5.4	6.7	6.2	5.1	5.0
9	5.6	5.1	5.05	4.8	5.5	6.7	6.0	5.1	5.0
10	5.6	5.1	5.05	4.8	5.45	6.7	5.85	5.1	5.0
11	5.15	5.1	5.15	4.8	5.55	6.7	5.65	5.15	5.0
12	5.3	5.1	5.0	4.8	5.55	6.6	5.6	5.1	5.0
13	5.3	5.1	5.0	4.8	5.5	6.45	5.6	5.1	5.0
14	5.2	5.1	5.0	4.7	5.4	6.45	5.5	5.1	5.0
15	5.4	5.0	5.1	4.7	5.35	6.5	5.5	5.1	5.0
16	5.3	5.0	5.1	4.7	5.4	6.5	5.5	5.1	4.9
17	5.2	5.0	5.1	4.7	5.4	6.65	5.5	5.1	4.9
18	5.1	5.0	5.15	4.7	5.5	6.85	5.4	5.15	4.9
19	5.1	5.0	5.25	4.95	5.75	6.95	5.4	5.4	4.9
20	5.15	5.0	5.3	4.9	5.85	7.15	5.4	5.25	4.9
21	5.1	5.0	5.3	4.95	5.9	7.15	5.4	5.2	4.9
22	5.1	5.0	5.45	5.0	5.95	7.1	5.4	5.15	4.9
23	5.1	5.0	5.5	5.0	6.0	7.1	5.5	5.1	4.9
24	5.1	5.0	5.5	5.0	5.85	7.0	5.5	5.1	4.9
25	5.3	5.0	5.5	5.0	5.75	7.0	5.4	5.1	4.9
26	5.4	5.0	5.5	5.1	5.55	6.9	5.3	5.1	4.8
27	5.2	5.0	5.35	5.1	5.55	7.0	5.3	5.0	4.8
28	5.2	5.1	5.3	5.3	5.75	6.95	5.2	5.0	4.8
29	5.1	....	5.2	5.25	5.85	6.9	5.2	5.0	4.8
30	5.0	....	5.1	5.0	5.7	6.8	5.2	5.0	4.8
31	5.0	....	5.1	....	5.6	....	5.1	5.0	....

NOTE.—Gage heights probably affected by ice from Jan. 1 to Apr. 16.

Daily discharge, in second-feet, of Fraser River at Granby, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	......	107	581	1,510	226	185	16	......	380	1,240	444	226	150
2	......	83	581	1,510	226	185	17	......	380	1.380	444	226	150
3	......	107	692	1,510	226	185	18	52	444	1,560	380	249	150
4	......	150	810	1,420	226	185	19	107	618	1,650	380	380	150
5	......	511	1,110	1,280	226	226	20	94	692	1,840	380	298	150
6	......	478	1,240	1,200	226	226	21	107	730	1,840	380	272	150
7	......	380	1,330	1,110	226	226	22	120	770	1,790	380	249	150
8	......	380	1,420	976	226	185	23	120	810	1,790	444	226	150
9	......	444	1,420	810	226	185	24	120	692	1.700	444	226	150
10	......	412	1,420	692	226	185	25	120	618	1,700	380	226	150
11	......	478	1,420	546	249	185	26	150	478	1,610	323	226	120
12	......	478	1,330	511	226	185	27	150	478	1,700	323	185	120
13	......	444	1,200	511	226	185	28	226	618	1,650	272	185	120
14	......	380	1,200	444	226	185	29	206	692	1,610	272	185	120
15	......	352	1,240	444	226	185	30	120	581	1,510	272	185	120
							31	......	511	......	226	185	......

NOTE.—These discharges are based upon rating curves applicable as follows: Apr. 17 to May 4, not well defined; May 5 to Sept. 30, fairly well defined.

Monthly discharge of Fraser River at Granby, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January			[a]45	2,770	D.
February			[a]45	2,500	D.
March			[a]45	2,770	D.
April	226		[b]83.6	4,970	D.
May	810	83	473	29,100	B.
June	1,840	581	1,390	82,700	B.
July	1,510	226	653	40,200	B.
August	380	185	230	14,100	B.
September	226	120	167	9,940	B.
The period				189,000	

[a] Estimated.

[b] Apr 1-17 estimated as equivalent to 48 second-feet per day.

COOPERATIVE DATA FOR STATIONS IN FRASER RIVER BASIN.

DESCRIPTION.

The data for the following stations in the Fraser River drainage are published practically without change as received from cooperating engineers. The computations have in general been made to conform with the computation rules used by the United States Geological Survey. On all the streams except Big Jim, Little Jim, and Elk Creek, on each of which the station was established at the mouth, there is an upper and a lower station. At all the upper stations a Lallie automatic gage was used to get the fluctuations in the daily gage height, which on the upper reaches of mountain streams are considerable.

Each upper station is at an altitude of about 10,000 feet, and several of the streams head in the vicinity of Corona, on the "Moffat road" (Denver, Northwestern & Pacific Railway). The United States Weather Bureau has for some time maintained a station near Corona at an altitude of 11,660 feet above sea level, and it is believed that the records of precipitation at this station will represent closely the average for the drainage areas of the upper gaging stations.

Unfortunately no published map shows accurately the drainage areas and location of these streams, so that it is rather difficult to define the exact location of the gaging stations.

Little use is made of the water except along the lower courses of the streams, where some water is diverted for meadow irrigation during the summer months. A scheme is contemplated to divert most of the water by tunnel through the continental divide to the head waters of the South Boulder Creek.

Most of these stations were established in June, 1907, and some measurements were made, but some of the gages were not established until the spring of 1908. All were discontinued in 1909 except the upper station on the Fraser, which is still being maintained.

The flow of the streams is little affected by ice.

FRASER RIVER AT UPPER STATION NEAR FRASER, COLO.

This station, which was established May 1, 1908, is located about 10 miles above Fraser post office, Colo., at an elevation of approximately 10,000 feet above sea level. The drainage area is about 9 square miles. Currant Creek is the only important tributary above.

The location and datum of the Lallie automatic gage have remained constant since station was established.

Discharge measurements of Fraser River at upper station near Fraser, Colo., in 1908–9.

Date.	Hydrographer.	Gage height.	Discharge.
1908.		*Feet.*	*Sec.-ft.*
May 2	Stanley Krajicek	0.60	7.5
17	.....do	1.00	28.4
28	.....do	.80	15.0
June 7	.....do	1.20	54.7
9	.....do	1.60	120
10	.....do	1.50	115
21	.....do	1.30	70
24	.....do	1.25	56.5
July 5	.....do	.95	28.5
13	.....do	.70	12.7
25	.....do	.75	19.0
30	.....do	.80	19.1
Aug. 28	.....do	.60	9.8
Sept. 16	.....do	.55	6.9
1909.			
July 7	N. O'Daniels	1.15	106
12	.....do	.90	48
27	.....do	.80	35
30	.....do	.75	31
Aug. 5	.....do	.65	24
Sept. 4	.....do	.60	21
Oct. 14	.....do	.40	10
28	.....do	.55	12

Daily gage height, in feet, of Fraser River at upper station near Fraser, Colo., for 1908–9.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	0.56	1.12	0.93	0.75	0.55	0.55	16	0.85	1.30	0.75	0.72	0.55	......
2	.60	1.16	.97	.75	.55	.50	17	.90	1.35	.72	.73	.55	......
3	.70	1.30	.95	.75	.60	.50	18	.95	1.30	.80	.72	.55	......
4	.70	1.38	.95	.72	.60	.50	19	1.07	1.23	.83	.73	.55	......
5	.70	1.37	.95	.75	.60	.50	20	1.00	1.30	.80	.70	.55	......
6	.70	1.27	.85	.85	.60	.50	21	.95	1.27	.80	.70	.55	......
7	.70	1.33	.85	.75	.60	.50	22	.97	1.38	.80	.70	.55	......
8	.70	1.17	.97	.75	.60	.50	23	1.00	1.25	.88	.70	.50	......
9	.70	1.40	.95	.75	.60	.50	24	.95	1.23	.75	.70	.50	......
10	.70	1.55	.80	.72	.60	.50	25	.85	1.20	.75	.68	.50	......
11	.70	1.50	.80	.73	.60	.50	26	.93	1.10	.88	.65	.50	......
12	.70	1.60	.80	.72	.60	.50	27	.95	1.25	.75	.63	.50	......
13	.70	1.40	.78	.72	.60	.50	28	.85	1.10	.78	.60	.50	......
14	.70	1.25	.78	.72	.60	.50	29	.87	1.10	.75	.60	.50	......
15	.80	1.30	.80	.73	.60	......	30	.80	.93	.85	.60	.50	......
							31	.95	......	.83	.60	......	......

Daily gage height, in feet, of Fraser River at upper station near Fraser, Colo., for 1908-9—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	1.30	0.75	0.60	0.60	0.50	16	0.85	0.60	0.70	0.40	....
2	1.30	.75	.60	.60	.50	17	.85	.90	.70	.40	....
3	1.25	.70	.60	.50	.50	18	.85	.70	.70	.35	....
4	1.25	.70	.60	.50	.50	19	.90	.70	.70	.35	....
5	1.20	.65	.60	.50	.50	20	.90	.70	.70	.30	....
6	1.20	.70	.60	.50	.60	21	.85	.70	.70	.25	....
7	1.15	.70	.65	.50	.55	22	.85	.70	.70	.50	....
8	1.10	.70	.65	.50	.55	23	.85	.70	.70	.50	....
9	1.05	.80	.65	.50	.50	24	.85	.70	.65	.50	....
10	1.00	.80	.70	.50	.45	25	.80	.70	.65	.50	....
11	.95	.80	.70	.45	.30	26	.80	.70	.65	.50	....
12	.90	.80	.70	.45	.40	27	.80	.70	.65	.50	....
13	.90	.70	.70	.40	.40	28	.80	.70	.65	.55	....
14	.90	.70	.70	.40	.40	29	.80	.70	.65	.50	....
15	.85	.70	.70	.40	....	30	.75	.70	.65	.50	....
						31	.75	.60	....	.50	....

Daily discharge, in second-feet, of Fraser River at upper station, near Fraser, Colo., for 1908-9.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	7	46	27	15	7	7	16	22	70	15	14	7	......
2	8	51	30	15	7	5	17	25	77	14	14	7	......
3	13	70	34	15	8	5	18	29	70	18	14	7	......
4	13	82	34	14	8	5	19	41	60	20	14	7	......
5	13	81	34	15	8	5	20	34	70	18	13	7	......
6	13	65	21	22	8	5	21	29	65	18	13	7	......
7	13	73	21	15	8	5	22	31	82	18	13	7	......
8	13	52	30	15	8	5	23	34	62	24	13	5	......
9	13	85	34	15	8	5	24	29	60	15	13	5	......
10	13	115	18	14	8	5	25	29	56	15	12	5	......
11	13	105	18	14	8	5	26	27	44	24	11	5	......
12	13	125	18	14	8	5	27	29	60	15	10	5	......
13	13	85	17	14	8	5	28	22	44	17	8	5	......
14	13	62	17	14	8	5	29	23	44	15	8	5	......
15	18	70	18	14	8	......	30	25	27	22	8	5	......
							31	29	......	20	8	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	140	31	21	21	10.5	16	40	21	27	10	....
2	140	31	21	21	10.5	17	40	48	27	10	....
3	128	27	21	15	10.5	18	40	27	27	8	....
4	128	27	21	15	10.5	19	48	27	27	8	....
5	114	24	21	15	10.5	20	48	27	27	6	....
6	114	27	21	15	15	21	40	27	27	5	....
7	106	27	24	15	12	22	40	27	27	10.5	....
8	92	27	24	15	12	23	40	27	27	10.5	....
9	81	35	24	15	10.5	24	40	27	24	10.5	....
10	66	35	27	15	9.5	25	35	27	24	10.5	....
11	56	35	27	13	8	26	35	27	24	10.5	....
12	48	35	27	13	9	27	35	27	24	10.5	....
13	48	27	27	10	9	28	35	27	24	12	....
14	48	27	27	10	9	29	35	27	24	10.5	....
15	40	27	27	10	....	30	31	27	24	10.5	....
						31	31	21	....	10.5	....

Monthly discharge of Fraser River at upper station near Fraser, Colo., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
May	41	7	20.9	1,290
June	125	27	68.6	4,080
July	34	14	21.3	1,300
August	22	8	13.3	818
September	8	5	6.9	411
Oct. 1-14	7	5	5.1	142
1909.				
July	140	31	63.3	3,890
August	48	21	28.5	1,750
September	27	21	24.8	1,480
October	21	5	12.0	738
Nov. 1-14	15	8	10.5	292

FRASER RIVER AT LOWER STATION NEAR FRASER, COLO.

This station, which was established June 1, 1907, and discontinued October 30, 1909, is located about 6 miles above Fraser post office, Colo., one-fourth mile below the mouth of Jim Creek and about 3 miles above the mouth of Vasquez River.

The drainage area is approximately 24 square miles. The location and datum of the rod gage remained constant while the station was being maintained.

Discharge measurements of Fraser River at lower station near Fraser, Colo., in 1907-1909.

Date.	Hydrographer.	Gage height.	Discharge.
1907.		*Feet.*	*Sec.-ft.*
June 6	G. M. Bull	1.60	100
12	do	1.70	105
July 2	do	2.55	196
Aug. 2	do	1.40	50
15	do	1.05	30
23	do	.80	23
1908.			
Apr. 28	Stanley Krajicek	.30	21
May 14	do	.85	43
18	do	1.20	60
26	do	1.30	71
June 11	do	2.50	250
21	do	1.60	103
July 4	do	1.60	99
19	do	1.10	56
30	do	1.00	56
Aug. 11	do	.80	48
22	do	.60	41
Sept. 3	do	.40	33
21	do	.25	24
1909.			
July 6	N. O'Daniels	2.00	320
12	do	1.45	145
19	do	1.25	115
30	do	.90	72
Aug. 5	do	.75	57
12	do	.75	57
20	do	1.00	83
24	do	.80	62
Sept. 3	do	.60	42
Oct. 18	do	.35	23

Daily gage height, in feet, of Fraser River at lower station near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	0.54	......	1.40	11	......	......	1.08	21	2.45	......	0.90
2	......	2.55	1.40	12	1.70	......	1.05	22	2.70	......	......
3	......	......	1.40	13	2.05	2.45	1.00	23	......	......	.80
4	......	2.50	1.30	14	......	......	......	24	......	......	......
5	......	2.55	1.28	15	2.80	2.00	1.05	25	3.00	......	......
6	1.60	......	1.25	16	2.55	......	.98	26	......	......	......
7	1.60	2.45	1.20	17	2.80	1.90	.95	27	......	......	......
8	1.70	......	1.18	18	2.85	......	......	28	2.80	1.75	......
9	......	......	1.18	19	2.70	1.80	......	29	......	......	......
10	......	......	1.15	20	2.60	......	......	30	......	1.60	......
								31	......	1.50	......

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	0.40	1.40	......	1.00	......	0.25	16	1.00	2.40	1.22	0.80	0.40	......
2	.40	1.60	1.20	.98	......	.25	17	1.10	2.35	1.14	.79	.40	......
3	.40	1.70	1.60	.95	0.40	.25	18	1.20	2.30	1.10	.78	.37	......
4	.40	1.80	......	.92	.40	.25	19	1.35	2.20	1.10	.77	.34	......
5	.40	1.80	1.52	.89	.40	.25	20	1.50	2.20	1.10	.76	.31	......
6	.40	1.90	1.46	.86	.40	.25	21	1.49	2.00	1.10	.75	.25	......
7	.40	1.85	1.40	.83	.40	.25	22	1.48	2.30	1.10	.74	.25	......
8	.40	1.80	1.45	.80	.40	.25	23	1.47	2.36	1.10	.73	.25	......
9	.40	1.75	1.49	.80	.40	.25	24	1.44	2.92	1.10	.71	.25	......
10	.30	2.15	1.40	.80	.40	.25	25	1.40	2.48	1.10	.70	.25	......
11	.50	2.50	1.35	.80	.40	.25	26	1.30	2.50	1.10	.68	.25	......
12	.60	2.50	1.30	.80	.40	.25	27	1.20	2.30	1.10	.66	.25	......
13	.75	2.45	1.30	.80	.40	.25	28	1.10	1.85	1.10	.63	.25	......
14	.85	2.45	1.30	.80	.40	.25	29	1.10	1.57	1.05	.60	.25	......
15	.95	2.40	1.30	.80	.40	......	30	1.12	1.29	1.00	.59	.25	......
							31	1.15	......	1.00	.59	......	......

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1909.					1909.				
1	......	......	0.65	0.65	16	......	......	......	......
2	......	0.85	......	......	17	1.25	0.75	......	......
3	......	......	.65	......	18	......	1.25	......	0.35
4	2.10	......	......	.50	19	1.25	1.20	......	......
5	......	.75	......	......	20	......	1.00	......	......
6	2.0	.75	.65	......	21	......	.90	0.75	......
7	......	.80	.80	......	22	1.20	......	.75	......
8	1.80	......	.80	.50	23	1.20	......	.75	.40
9	1.75	......	.90	.50	24	......	.80	.75	......
10	......	.80	.85	......	25	......	.75	.75	.40
11	......	......	......	.50	26	......	.70	......	......
12	1.45	.75	......	.50	27	......	.70	.70	.40
13	1.40	.75	......	.45	28	......	......	......	......
14	1.35	.75	......	......	29	......	.65	......	......
15	......	......	......	......	30	.90	.65	.70	.35
					31	.90	......	......	......

Daily discharge, in second-feet, of Fraser River at lower station near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	35	200	49	11	105	180	34	21	180	105	26
2	48	196	49	12	105	180	30	22	205	105	24
3	61	192	49	13	126	180	28	23	220	105	23
4	74	185	45	14	185	140	29	24	235	105	22
5	87	196	44	15	210	105	30	25	250	105	21
6	100	188	42	16	196	100	28	26	238	105	19
7	100	180	40	17	210	100	28	27	224	105	18
8	105	180	38	18	225	108	28	28	210	105	17
9	105	180	38	19	205	105	27	29	207	104	16
10	105	180	36	20	200	105	27	30	203	105	15
								31	......	75	15

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	25	85	72	55	25	20	16	55	217	71	43	25	......
2	25	108	69	54	25	20	17	62	208	64	42	25	......
3	25	118	108	52	25	20	18	69	200	62	42	24	......
4	25	130	104	50	25	20	19	81	185	62	41	23	......
5	25	130	100	48	25	20	20	95	185	62	41	22	......
6	25	142	90	47	25	20	21	93	155	62	40	20	......
7	25	135	85	45	25	20	22	92	200	62	40	20	......
8	25	130	81	43	25	20	23	91	210	62	40	20	......
9	25	125	93	43	25	20	24	89	220	62	39	20	......
10	22	175	85	43	25	20	25	85	230	62	38	20	......
11	29	235	81	43	25	20	26	77	238	62	37	20	......
12	33	235	77	43	25	20	27	69	200	62	35	20	......
13	41	225	77	43	25	20	28	62	135	62	35	20	......
14	46	225	77	43	25	20	29	62	103	58	33	20	......
15	52	217	77	43	25	......	30	63	76	55	33	20	......
							31	66	......	55	33	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	420	68	47	47	25	16	121	57	62	25	....
2	420	68	47	42	25	17	115	57	57	23	....
3	375	68	47	38	25	18	115	115	57	23	....
4	375	57	47	34	25	19	115	108	57	23	....
5	320	57	47	34	23	20	115	83	57	23	....
6	320	57	47	34	23	21	108	72	57	23	....
7	265	62	62	34	23	22	108	72	57	25	....
8	225	62	62	34	23	23	108	68	57	25	....
9	210	62	72	34	23	24	108	62	57	25	....
10	185	62	68	34	23	25	102	57	57	25	....
11	165	57	68	34	23	26	95	52	57	25	....
12	145	57	68	34	23	27	90	52	52	25	....
13	137	57	68	30	23	28	83	52	52	25	....
14	128	57	62	30	23	29	77	47	52	25	....
15	121	57	62	25	....	30	72	47	52	23	....
						31	72	47	....	23	....

NOTE.—Discharges estimated for days on which gage was not read.

Monthly discharge of Fraser River at lower station near Fraser, Colo., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	250	35	160.0	9,590
July	200	75	100.0	8,600
August	49	15	30.0	1,870
1908.				
May	95	25	53.5	3,290
June	238	76	173.0	10,300
July	108	55	72.9	4,480
August	55	33	42.2	2,600
September	25	20	23.1	1,370
Oct. 1–14	20	20	20.0	555
1909.				
July	420	72	175.0	10,800
August	115	47	63.1	3,880
September	72	47	57.1	3,400
October	47	23	29.2	1,800
Nov. 1–14	25	23	23.6	655

BIG (EAST) JIM CREEK AT MOUTH, NEAR FRASER, COLO.

Jim Creek drains the west slope of James Peak, and the two branches, East, or Big Jim, and the West, or Little Jim, unite a short distance above the point where they enter the Fraser River, some 6 miles above Fraser post office, Colo. The drainage area of the two creeks is about 7½ square miles.

This station, which was established June 1, 1907, and discontinued November 11, 1909, is located just above the junction of the Big and Little Jim, about 1 mile above Idlewild ranger station.

The location and datum of the rod gage remained constant while the station was being maintained.

Discharge measurements of Big Jim Creek at mouth, near Fraser, Colo., 1907–1909.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
1907.			
June 1	G. M. Bull	0.30	5.6
12	.....do	.60	15.0
July 2	.....do	.90	36.0
Aug. 6	.....do	.45	8.3
15	.....do	.35	6.2
1908.			
May 20	Stanley Krajicek	.40	10.7
26	.....do	.50	12.4
June 2	.....do	.50	13.4
11	.....do	.95	44.7
22	.....do	.90	45.4
July 4	.....do	.65	25.7
19	.....do	.40	13.7
23	.....do	.40	12.5
Aug. 11	.....do	.34	9.8
29	.....do	.27	7.4
Sept. 3	.....do	.20	5.4
21	.....do	.10	3.5
1909.			
July 10	N. O'Daniels	.95	38.5
12	.....do	.85	34.0
30	.....do	.60	18.5
Aug. 5	.....do	.50	14.5
12	.....do	.50	14.5
20	.....do	.70	24.5
Sept. 3	.....do	.45	12.5
Oct. 18	.....do	.30	7.0

Daily gage height, in feet, of Big Jim Creek at mouth, near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	0.30		0.50	11			0.38	21	0.70		0.30
2		0.90	.50	12	0.60		.40	22	.85		
3			.50	13	.70	0.85	.35	23			.30
4		.85	.50	14				24			
5		.85	.50	15	.90	.65	.35	25	.95		
6	.55		.45	16	.75		.30	26			
7	.55	.86	.48	17	.90	.65		27			
7	.60		.40	18	.90			28	.90	0.55	
9			.40	19	.80	.65		29			
10			.40	20	.80			30		.58	
								31		.53	

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1908.								1908.							
1		0.20	0.30	0.55	0.40	0.20	0.18	16		0.40	0.80	0.40	0.18	0.18	
2		.20	.40	.55	.40	.20	.18	17		.40	.85	.40	.16	.18	
3		.20	.40	.55	.39	.20	.18	18		.40	.85	.40	.15	.18	
4		.25	.50	.55	.39	.20	.18	19		.40	.90	.40	.14	.18	
5		.25	.50	.55	.37	.20	.18	20		.40	.90	.40	.12	.18	
6		.30	.60	.55	.36	.20	.18	21		.40	.90	.40	.10	.18	
7		.30	.60	.55	.35	.20	.18	22		.40	.90	.40	.13	.18	
8		.30	.55	.55	.34	.20	.18	23		.40	.90	.40	.18	.18	
9		.30	.55	.55	.34	.19	.18	24		.40	.90	.40	.18	.18	
10		.30	.75	.55	.34	.19	.18	25		.40	.85	.40	.20	.18	
11		.30	.95	.53	.34	.19	.18	26		.40	.85	.40	.21	.18	
12		.30	.80	.50	.32	.19	.18	27		.35	.77	.40	.22	.18	
13		.35	.80	.47	.28	.19	.18	28	0.30	.30	.70	.40	.24	.18	
14		.35	.80	.44	.24	.19	.18	29	.25	.30	.70	.40	.27	.18	
15		.40	.80	.40	.20	.19		30	.25	.30	.68	.40	.27	.18	
								31		.30		.40			

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1			0.45	0.40		16		0.50			
2						17	0.75	.50			
3			.45			18	.70	.70		0.30	
4				.40	0.30	19	.70	.80			
5		0.50				20		.70	0.50		
6	1.20		.50		.30	21		.60			
7			.60			22		.60	.50		
8	1.10		.80	.40		23	.70	.50	.50	.30	
9	1.05		.65	.40	.30	24		.50			
10	.95	.50	.65			25		.50		.35	
11				.40	.30	26					
12	.85	.50		.40		27		.50			
13	.80			.40		28					
14	.80					29					
15		.50				30	.60	.50		.30	
						31					

Daily discharge, in second-feet, of Big Jim Creek at mouth, near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	5.6	36	11	11	15	30	7	21	20	15	6
2	7	36	11	12	15	30	8	22	31	15	6
3	8	34	11	13	20	31	6	23	34	15	6
4	10	31	11	14	28	25	6	24	37	14	6
5	12	31	11	15	36	18	6	25	40	14	6
6	14	29	8.3	16	24	18	6	26	39	14	5
7	14	27	10	17	36	18	6	27	37	14	5
8	15	28	8	18	36	17	6	28	36	14	5
9	15	28	8	19	27	15	6	29	36	14	4
10	15	29	8	20	27	15	6	30	36	15	4
								31	......	14	4

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	5	9	20	13	5	5	16	13	35	13	5	5	......
2	5	13	20	13	5	5	17	13	39	13	4	5	......
3	5	13	20	12	5	5	18	13	39	13	4	5	......
4	7	17	20	11	5	5	19	13	43	13	4	5	......
5	7	17	20	11	5	5	20	13	43	13	3	5	......
6	9	22	20	10	5	5	21	13	43	13	3	5	......
7	9	22	20	10	5	5	22	13	43	13	4	5	......
8	9	20	20	10	5	5	23	13	43	13	4	5	......
9	9	20	20	10	5	5	24	13	43	13	5	5	......
10	9	32	20	10	5	5	25	13	39	13	5	5	......
11	9	47	19	10	5	5	26	13	39	13	6	5	......
12	9	35	17	9	5	5	27	10	33	13	6	5	......
13	10	35	16	8	5	5	28	9	29	13	7	5	......
14	10	35	14	7	5	5	29	9	29	13	8	5	......
15	13	35	13	5	5	......	30	9	27	13	8	5	......
							31	9	......	13	......	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	70	16.5	12.5	10.5	10.5	16	28	14.5	18.5	8.5	....
2	70	16.5	12.5	10.5	10.5	17	28	14.5	16.5	8.5	....
3	65	16.5	12.5	10.5	10.5	18	24.5	24.5	16.5	7	....
4	60	14.5	12.5	10.5	7	19	24.5	31	16.5	7	....
5	55	14.5	14.5	10.5	7	20	24.5	24.5	14.5	7	....
6	50	14.5	14.5	10.5	7	21	24.5	18.5	14.5	7	....
7	47	14.5	18.5	10.5	7	22	24.5	18.5	14.5	7	....
8	45	14.5	31	10.5	7	23	24.5	14.5	14.5	7	....
9	43	14.5	21	10.5	7	24	24.5	14.5	14.5	8.5	....
10	38.5	14.5	21	10.5	7	25	24.5	14.5	14.5	8.5	....
11	36	14.5	21	10.5	7	26	24.5	14.5	14.5	8.5	....
12	34	14.5	21	10.5	7	27	21	14.5	12.5	8.5	....
13	31	14.5	18.5	10.5	7	28	21	14.5	12.5	7	....
14	31	14.5	18.5	10.5	7	29	21	14.5	10.5	7	....
15	31	14.5	18.5	10.5	....	30	18.5	14.5	10.5	7	....
						31	18.5	14.5	....	7	....

NOTE.—Discharges interpolated for days on which gage was not read.

Monthly discharge of Big Jim Creek at mouth, near Fraser, Colo., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	40	6	24	1,450
July	36	14	22	1,370
August	11	4	7	434
1908.				
April 28–30	9	7	7.7	45
May	13	5	10.1	621
June	47	9	31.3	1,860
July	20	13	15.7	965
August	13	3	7.5	446
September	5	5	5.0	297
October 1–14	5	5	5.0	139
1909.				
July	70	18.5	35.0	2,150
August	31	14.5	16.1	990
September	31	10.5	16.1	958
October	10.5	7	8.98	552
November 1–14	10.5	7	7.75	215

LITTLE (WEST) JIM CREEK AT MOUTH, NEAR FRASER, COLO.

This station, which was established June 1, 1907, and discontinued September 3, 1909, is located just above the junction of the Little Jim with the Big Jim, about 6 miles above the Fraser and at an elevation of about 9,000 feet above sea level.

The location and datum of the rod gage remained constant while the station was being maintained.

Discharge measurements of Little Jim Creek at mouth, near Fraser, Colo., in 1907–1909.

Date.	Hydrographer.	Gage height.	Discharge.
1907.		*Feet.*	*Sec.-ft.*
June 1	G. M. Bull	1.02	3.0
12	.....do	1.55	9.6
July 2	.....do	1.90	17.1
Aug. 6	.....do	1.00	1.9
23	.....do	.85	1.2
1908.			
May 20	Stanley Krajicek	.73	2.4
26	.....do	.70	2.2
June 2	.....do	.80	3.1
11	.....do	1.70	14.2
July 4	.....do	1.20	5.9
19	.....do	.70	2.1
23	.....do	.70	2.2
Aug. 11	.....do	.60	1.2
29	.....do	.58	.9
Sept. 3	.....do	.58	.9
21	.....do	.50	.5
1909.			
July 10	N. O'Daniels	1.50	13
12	.....do	1.30	7.5
23	.....do	1.00	4.0
30	.....do	.90	3.0
Aug. 5	.....do	.70	1.5
12	.....do	.70	1.5
17	.....do	.65	1.3
20	.....do	.95	3.20
24	.....do	.65	1.3
Sept. 3	.....do	.50	.5

Daily gage height, in feet, of Little Jim Creek at mouth, near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	1.02	......	1.10	11	......	......	0.95	21	1.75	......	0.80
2	......	1.90	1.05	12	1.55	......	.90	22	1.85	......	......
3	......	......	......	13	1.70	1.75	.90	23	......	......	.85
4	......	1.70	1.08	14	......	......	......	24	......	......	......
5	......	1.75	1.00	15	1.95	1.55	.90	25	1.95	......	......
6	1.45	......	1.00	16	1.80	......	.80	26	......	......	......
7	1.45	1.70	1.00	17	1.90	1.50	......	27	......	......	......
8	1.50	......	.98	18	1.90	......	......	28	1.90	1.35	......
9	......	......	.98	19	1.85	1.35	......	29	......	......	......
10	......	......	.93	20	1.85	......	......	30	......	1.20	......
								31	......	1.13	......

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1908.								1908.							
1	......	0.50	0.80	1.20	0.70	0.58	0.50	16	......	.75	1.50	0.81	0.50	0.56	......
2	......	.50	.80	1.20	.70	.58	.50	17	......	.75	1.50	.80	.50	.56	......
3	......	.50	.85	1.20	.69	.58	.50	18	......	.75	1.50	.75	.50	.56	......
4	......	.50	.90	1.20	.68	.58	.50	19	......	.74	1.50	.70	.50	.56	......
5	......	.55	1.00	1.20	.66	.58	.50	20	......	.73	1.50	.70	.50	.56	......
6	......	.55	1.10	1.20	.64	.58	.50	21	......	.75	1.55	.70	.50	.56	......
7	......	.55	1.10	1.20	.62	.58	.50	22	......	.75	1.60	.70	.50	.56	......
8	......	.60	1.10	1.13	.60	.58	.50	23	......	.75	1.60	.70	.50	.56	......
9	......	.60	1.10	1.07	.60	.58	.50	24	......	.80	1.55	.70	.50	.56	......
10	......	.65	1.40	1.00	.60	.58	.50	25	......	.80	1.55	.70	.50	.56	......
11	......	.65	1.70	.93	.60	.57	.50	26	......	.70	1.50	.70	.52	.56	......
12	......	.65	1.60	.87	.58	.56	.50	27	......	.65	1.45	.70	.54	.56	......
13	......	.70	1.55	.85	.56	.55	.50	28	0.70	.60	1.40	.70	.56	.56	......
14	......	.70	1.55	.84	.53	.55	.50	29	.65	.60	1.32	.70	.58	.56	......
15	......	.75	1.50	.82	.50	.55	......	30	.60	.60	1.24	.70	.56	.56	......
								31	......	.60	......	.70	......	......	......

Day.	July.	Aug.	Day.	July.	Aug.	Day.	July.	Aug.
1909.			1909.			1909.		
1	......	......	11	......	......	21	......	......
2	......	......	12	1.30	.70	22	......	......
3	......	......	13	1.25	......	23	1.00	......
4	......	......	14	1.20	......	24	......	0.65
5	......	0.70	15	......	......	25	......	......
6	......	......	16	......	......	26	......	......
7	......	......	17	1.15	.65	27	......	.60
8	1.60	......	18	......	......	28	......	......
9	1.60	......	19	1.10	1.20	29	......	......
10	1.50	.65	20	......	.95	30	.90	......
						31	......	......

Daily discharge, in second-feet, of Little Jim Creek at mouth, near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	3	17	3	11	9	14	2	21	14	6	1
2	4	17	3	12	9.6	14	2	22	16	6	1
3	5	15	3	13	13	14	2	23	17	6	1.2
4	6	13	3	14	16	12	2	24	18	6	1
5	7	14	2	15	19	10	2	25	19	6	1
6	8	14	1.9	16	15	10	1	26	19	6	1
7	8	13	2	17	17	9	1	27	18	6	1
8	9	13	2	18	17	7	1	28	17	6	1
9	9	13	2	19	16	6	1	29	17	5	1
10	9	13	2	20	16	6	1	30	17	4	1
								31	......	4	1

Daily discharge, in second-feet, of Little Jim Creek at mouth, near Fraser, Colo., for 1907–1909—Continued.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1908.								1908.							
1	......	1	2	6	2	1.4	1.1	16	......	2	10	3	1	1.3	......
2	......	1	2	6	2	1.4	1.1	17	......	2	10	3	1	1.3	......
3	......	1	3	6	2	1.4	1.1	18	......	2	10	2	1	1.3	......
4	......	1	3	6	2	1.4	1.1	19	......	2	10	2	1	1.3	......
5	......	1	4	6	2	1.4	1.1	20	......	2	10	2	1	1.3	......
6	......	1	5	6	2	1.4	1.1	21	......	2	11	2	1	1.3	......
7	......	1	5	6	2	1.4	1.1	22	......	2	12	2	1	1.3	......
8	......	2	5	5	2	1.4	1.1	23	......	2	12	2	1	1.3	......
9	......	2	5	5	2	1.4	1.1	24	......	3	11	2	1	1.3	......
10	......	2	8	4	2	1.4	1.1	25	......	3	11	2	1	1.3	......
11	......	2	14	3	2	1.4	1.1	26	......	2	10	2	1	1.3	......
12	......	2	12	3	1	1.3	1.1	27	......	2	9	2	1	1.3	......
13	......	2	11	3	1	1.3	1.1	28	2	2	8	2	1	1.3	......
14	......	2	11	3	1	1.3	1.1	29	2	2	7	2	1	1.3	......
15	......	2	10	3	1	1.3	......	30	2	2	6	2	1	1.3	......
								31	......	2	......	2	1	......	......

Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.	Day.	July.	Aug.	Sept.	Oct.
1909.					1909.					1909.				
1	23	2.5	1.0	0.4	11	10	1.5	1	0.4	21	4.5	2.5	0.7	......
2	23	2.0	.5	.4	12	7.5	1.5	1	.4	22	4.5	1.7	.7	......
3	21.5	1.7	.5	.4	13	7	1.3	1	......	23	4	1.5	.7	......
4	19.5	1.5	.5	.4	14	6	1.3	1	......	24	4	1.3	.7	......
5	19.5	1.5	.7	.4	15	6	1.5	.7	......	25	4	1.3	.7	......
6	16.5	1.5	1	.4	16	5.5	1.5	.7	......	26	4	1	.5	......
7	16.5	1.5	1	.4	17	5.5	1.3	.7	......	27	3.5	1	.5	......
8	16.5	1.3	1	.4	18	5.5	2	.7	......	28	3.5	1	.4	......
9	16.5	1.3	1	.4	19	5	6	.7	......	29	3	1	.4	......
10	13	1.3	1	.4	20	5	3.5	.7	......	30	3	1	.4	......
										31	3	1	......	......

NOTE.—Discharges interpolated for days when gage was not read. From Oct. 12 to Dec. 31, 1909, the flow was almost zero.

Monthly discharge of Little Jim Creek at mouth, near Fraser, Colo., for 1907–1909.

Month.	Discharge in second feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	19	3	12	756
July	17	4	10	610
August	3	1	2	100
1908.				
April 28–30	2	2	2	12
May	3	1	1.8	111
June	14	2	8.2	488
July	6	2	3.4	209
August	2	1	1.4	86
September	1.4	1.3	1.3	77
October 1–14	1.1	1.1	1.10	30
1909.				
July	23	3	9.34	574
August	6	1	1.67	103
September	1	.4	.74	44
October 1–12	.4	.4	.40	10

VASQUEZ RIVER AT UPPER STATION, NEAR FRASER, COLO.

Vasquez River is tributary to Fraser River from the west.

This station, which was established May 1, 1908, and discontinued November 9, 1909, is located about 4 miles above the mouth of the stream, at an elevation of approximately 10,000 feet above sea level.

The drainage area is about 9 square miles.

The location and datum of the Lallie automatic gage remained constant while the station was maintained.

Discharge measurements of Vasquez River at upper station near Fraser, Colo., 1908-9.

Date.	Hydrographer.	Gage height.	Discharge.
1908.		*Feet.*	*Sec.-ft.*
May 1	Stanley Krajicek	0.23	12.1
16	....do	.33	18.2
22	....do	.55	32.8
June 3	....do	.83	50.0
11	....do	1.15	63.5
17	....do	1.35	103
30	....do	.55	37.3
July 12	....do	.75	40.3
17	....do	.76	46.6
19	....do	.72	43.4
28	....do	.64	36.3
Sept. 19	....do	.30	14.0
1909.			
July 4	N. O'Daniels	1.90	208
14	....do	1.30	114
17	....do	1.25	107
30	....do	1.00	74
Aug. 5	....do	.85	58
12	....do	90	68
Sept. 20	....do	.70	42
Oct. 18	....do	.45	22

Daily gage height, in feet, of Vasquez River at upper station near Fraser, Colo., for 1908-9.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	0.48	0.53	0.38	0.34	0.34	16	1.41	0.75	0.34	0.34	....
2	.53	.53	.38	.34	.34	17	1.51	.75	.34	.34	....
3	.74	.53	.38	.34	.34	18	1.41	.75	.34	.34	....
4	1.12	.53	.38	.34	.34	19	1.42	.75	.34	.34	....
5	1.15	.53	.38	.34	.34	20	1.38	.75	.34	.34	....
6	1.29	.53	.38	.34	.34	21	1.25	.70	.34	.34	....
7	1.32	.41	.34	.34	.34	22	1.05	.70	.34	.34	....
8	1.41	.40	.34	.34	.34	23	1.12	.70	.34	.34	....
9	1.59	.48	.34	.34	.34	24	1.53	.69	.34	.34	....
10	1.50	.63	.34	.34	.34	25	1.41	.69	.34	.34	....
11	1.51	.75	.34	.34	.34	26	1.36	.64	.34	.34	....
12	1.42	.75	.34	.34	.34	27	1.48	.64	.34	.34	....
13	1.32	.75	.34	.34	.34	28	1.48	.64	.34	.34	....
14	1.32	.75	.34	.34	.34	29	1.48	.54	.34	.34	....
15	1.34	.75	.34	.34	....	30	1.48	.48	.34	.34	....
						31	....	.47	.34	....	....

Daily gage height, in feet, of Vasquez River at upper station near Fraser, Colo., for 1908-9—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	....	0.95	0.80	0.60	0.70	16	....	0.90	....	....	....
2	....	.95	.80	.60	....	17	1.25	1.00	0.85	....	....
3	....	.90	.80	.60	....	18	1.30	1.00	.90	0.45	....
4	1.90	.90	....	.60	....	19	1.40	1.00	....	....	....
5	....	.85	....	.60	....	20	1.25	.90	....	....	....
6	....	.85	....	.60	....	21	1.20	.90	.75	....	....
7	....	.90	....	.60	....	22	1.20	.85	....	....	....
8	....	.90	....	.60	....	23	1.25	.85	....	....	....
9	....	.90	....	....	.50	24	1.25	.85	....	....	....
10	....	.85	....	....	....	25	....	.80	....	....	....
11	....	.90	....	....	....	26	....	.80	.70	.50	....
12	....	.85	....	....	....	27	....	.80	.65	....	....
13	....	.85	....	....	....	28	....	.80	.65	....	....
14	1.30	.85	....	....	....	29	....	.80	.65	....	....
15	....	.85	....	....	....	30	1.00	.85	.60	....	....
						31	1.00	.85	....	....	....

Daily discharge, in second-feet, of Vasquez River at upper station near Fraser, Colo., for 1908-9.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	28	31	21	19	19	16	95	46	19	19	....
2	31	31	21	19	19	17	103	46	19	19	....
3	46	31	21	19	19	18	95	46	19	19	....
4	73	31	21	19	19	19	98	46	19	19	....
5	75	31	21	19	19	20	93	46	19	19	....
6	86	31	21	19	19	21	83	43	19	19	....
7	88	23	19	19	19	22	68	43	19	19	....
8	95	23	19	19	19	23	73	43	19	19	....
9	109	28	19	19	19	24	53	42	19	19	....
10	102	38	19	19	19	25	41	42	19	19	....
11	102	46	19	19	19	26	36	39	19	19	....
12	96	46	19	19	19	27	28	39	19	19	....
13	88	46	19	19	19	28	28	39	19	19	....
14	89	46	19	19	19	29	28	32	19	19	....
15	91	46	19	19	....	30	28	28	19	19	....
						31	....	27	19	....	....

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	225	67	52	32	42	16	107	63	52	22	....
2	225	67	52	32	42	17	107	74	58	22	....
3	216	63	52	32	37	18	114	74	63	22	....
4	208	63	52	32	37	19	128	74	58	22	....
5	200	58	52	32	32	20	107	63	52	22	....
6	192	58	52	32	32	21	101	63	47	22	....
7	175	63	52	32	24	22	101	58	42	22	....
8	167	63	52	32	24	23	107	58	42	22	....
9	159	63	52	32	24	24	107	58	42	24	....
10	143	58	47	27	24	25	107	52	42	24	....
11	135	63	47	27	22	26	101	52	42	24	....
12	128	58	47	24	22	27	95	52	37	22	....
13	121	58	47	24	22	28	88	52	37	22	....
14	114	58	42	24	22	29	82	52	37	22	....
15	114	58	47	22	....	30	74	58	32	27	....
						31	74	58	....	32	....

NOTE.—Discharges in 1909 estimated for days on which gage was not read.

Monthly discharge of Vasquez River at upper station near Fraser, Colo., for 1908–9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
June	109	28	71.6	4,260
July	46	23	37.9	2,330
August	21	19	19.4	1,190
September	19	19	19.0	1,130
October 1–14	19	19	19.0	528
1909.				
July	225	74	133	8,180
August	74	52	60.6	3,730
September	63	32	47.6	2,830
October	32	22	26.1	1,600
November 1–14	42	22	29.0	806

VASQUEZ RIVER AT LOWER STATION NEAR FRASER, COLO.

This station, which was established June 1, 1907 and discontinued November 9, 1909, is located about 1 mile above the mouth of the stream, at an elevation of probably 8,700 feet above sea level. The drainage area is about 12 square miles.

The location and datum of the rod gage remained constant while the station was being maintained.

Discharge measurements of Vasquez River at lower station near Fraser, Colo., in 1907–1909.

Date.	Hydrographer.	Gage height.	Discharge.
1907.		*Feet.*	*Sec.-ft.*
June 1	G. M. Bull	0.80	46
7	do	1.15	92
14	do	1.75	170
27	do	1.60	161
July 6	do	1.35	133
30	do	.95	72
Aug. 5	do	.80	52
13	do	.70	39
18	do	.60	31
1908.			
Apr. 29	Stanley Krajicek	.80	10.4
May 10	do	.80	11.3
14	do	1.50	23.0
23	do	1.63	46.4
25	do	1.80	66.0
June 2	do	1.90	79.3
9	do	2.00	93.2
11	do	2.5	177
July 25	do	1.72	52
Aug. 10	do	1.70	49.1
17	do	1.7	50.0
Sept. 22	do	1.40	16
1909.			
July 6	N. O'Daniels	1.50	243
13	do	1.10	125
30	do	.80	73
Aug. 5	do	.65	55
12	do	.65	55
20	do	.70	60
Sept. 20	do	.60	49
Oct. 18	do	.40	31

Daily gage height, in feet, of Vasquez River at lower station near Fraser, Colo., for 1907-1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	0.80	1.55	0.93	11	1.25	1.25	0.75	21	1.42	......	0.68
2	......	1.55	.93	12	1.10	1.20	.73	22	1.40	......	.60
3	......	1.50	.83	13	1.10	1.30	.70	23	1.50	......	.60
4	......	1.45	.80	14	1.75	1.30	.73	24	1.50	......	......
5	1.40	1.43	.80	15	1.65	1.15	.78	25	1.55	1.00	......
6	......	1.35	.78	16	1.50	1.10	.73	26	1.60	......	......
7	1.15	1.40	.78	17	1.40	1.10	.68	27	1.60	......	.60
8	1.20	1.40	.75	18	1.60	1.05	.60	28	1.50	.95	......
9	1.00	1.35	.75	19	1.48	1.00	.63	29	1.55	.95	......
10	.90	1.30	.73	20	1.45	1.00	.68	30	1.65	.93	......
								31	......	.88	......

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	1.00	1.00	0.72	0.43	0.44	16	1.20	0.80	0.69	0.45	......
2	1.02	.98	.72	.43	.44	17	1.20	.78	.68	.45	......
3	1.04	.95	.72	.43	.43	18	1.16	.76	.67	.45	......
4	1.06	.92	.71	.44	.43	19	1.12	.75	.66	.44	......
5	1.08	.90	.71	.44	.43	20	1.08	.75	.65	.43	......
6	1.10	.89	.71	.44	.42	21	1.04	.74	.64	.43	......
7	1.13	.89	.70	.44	.42	22	1.00	.73	.63	.43	......
8	1.15	.86	.70	.44	.42	23	1.00	.73	.62	.43	......
9	1.20	.85	.70	.44	.44	24	1.00	.72	.61	.43	......
10	1.20	.86	.70	.44	.46	25	1.00	.72	.60	.43	......
11	1.20	.86	.70	.44	.40	26	1.00	.72	.56	.43	......
12	1.20	.87	.70	.44	.40	27	1.00	.72	.52	.43	......
13	1.20	.86	.70	.44	.40	28	1.00	.72	.48	.43	......
14	1.20	.84	.70	.45	.40	29	1.00	.72	.45	.43	......
15	1.20	.82	.70	.45	......	30	1.00	.72	.45	.43	......
						31	......	.72	.45	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	......	......	0.60	0.50	0.50	16	......	......	......	......	......
2	......	......	......	......	......	17	......	0.65	......	......	......
3	......	......	.60	.50	......	18	......	......	......	0.40	......
4	1.70	......	......	......	......	19	......	.80	......	......	......
5	......	0.65	......	......	......	20	......	.70	0.70	......	......
6	1.50	......	......	......	.50	21	......	......	......	......	......
7	......	......	.60	......	.40	22	......	......	......	......	......
8	......	......	......	......	.30	23	0.90	......	.60	......	......
9	......	......	......	......	.30	24	......	.65	......	......	......
10	1.00	......	......	......	......	25	......	......	......	......	......
11	......	......	......	......	......	26	......	......	......	.30	......
12	......	.65	......	.50	......	27	......	.60	......	......	......
13	1.10	......	......	......	......	28	......	.60	......	......	......
14	......	......	......	......	......	29	......	.60	......	......	......
15	......	......	......	......	......	30	.80	.60	......	......	......
						31	......	.60	......	......	......

Daily discharge, in second-feet, of Vasquez River at lower station near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	46	148	65	11	108	108	42	21	130	76	38
2	66	148	65	12	90	103	42	22	128	76	31
3	86	142	53	13	90	115	39	23	142	76	31
4	106	135	52	14	170	115	42	24	142	76	31
5	128	135	52	15	164	92	48	25	148	76	31
6	110	133	48	16	142	90	42	26	160	75	31
7	92	128	48	17	128	90	38	27	161	74	31
8	103	128	45	18	160	84	31	28	142	72	31
9	76	133	45	19	140	76	32	29	148	72	31
10	64	115	42	20	135	76	38	30	164	65	31
								31	......	62	31

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	85	85	54	33	33	16	125	62	52	34	....
2	88	83	54	33	33	17	125	60	52	34	....
3	90	79	54	33	33	18	108	58	51	34	....
4	92	75	54	33	33	19	103	57	50	33	....
5	94	73	54	33	33	20	94	57	49	33	....
6	100	71	54	33	32	21	90	55	48	32	....
7	104	69	53	33	32	22	85	55	47	33	....
8	107	68	53	33	32	23	85	55	46	33	....
9	125	67	53	33	33	24	85	54	46	33	....
10	125	68	53	33	34	25	85	54	45	33	....
11	125	68	53	33	31	26	85	54	41	33	....
12	125	69	53	33	31	27	85	54	38	33	....
13	125	68	53	33	31	28	85	54	36	33	....
14	125	66	53	34	31	29	85	54	34	33	....
15	125	64	53	34	....	30	85	54	34	33	....
						31	....	54	34	....	....

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	370	66	49	39	39	16	115	55	49	35	....
2	350	66	49	39	39	17	115	55	73	31	....
3	315	60	49	39	39	18	103	60	79	31	....
4	315	60	49	39	39	19	103	73	73	31	....
5	280	55	49	39	39	20	103	60	60	31	....
6	243	55	49	39	39	21	95	60	49	31	....
7	208	55	49	39	31	22	95	60	49	31	....
8	164	55	49	39	22	23	86	60	49	31	....
9	125	55	49	39	22	24	86	55	49	27	....
10	103	55	49	39	22	25	86	55	49	27	....
11	103	55	49	39	22	26	79	49	49	22	....
12	125	55	49	39	22	27	79	49	49	22	....
13	125	55	49	39	22	28	73	49	45	22	....
14	125	55	49	39	22	29	73	49	45	22	....
15	115	55	49	35	....	30	73	49	39	31	....
						31	73	49	....	35	....

NOTE.—Discharges interpolated for days on which gage was not read.

Monthly discharge of Vasquez River at lower station near Fraser, Colo., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	170	46	122	7,340
July	148	62	100	6,190
August	65	31	40	2,510
1908.				
June	125	85	102	6,070
July	85	54	63.4	3,900
August	54	34	48.5	2,980
September	34	32	33.2	1,980
October 1–14	34	31	32.3	897
1909.				
July	370	73	145	8,920
August	73	49	56.3	3,460
September	79	39	51.4	3,060
October	39	22	33.6	2,070
November 1–14	39	22	29.9	830

ELK CREEK AT MOUTH, NEAR FRASER, COLO.

Elk Creek, the next important stream tributary to the Fraser below the Vasquez River, enters about 1 mile above Fraser post office. The drainage area is about 8 square miles.

The only station on this stream was located a short distance above its mouth. The datum and location of the rod gage remained constant while the station was maintained. The station was established June 5, 1907, and discontinued November 9, 1909.

Discharge measurements of Elk Creek at mouth, near Fraser, Colo., in 1907–1909.

Date.	Hydrographer.	Gage height.	Discharge.
1907.		*Feet.*	*Sec.-ft.*
June 5	G. M. Bull	0.92	28
July 16	.....do	.55	14
Aug. 9	.....do	.25	2
1908.			
May 7	Stanley Krajicek	1.40	11.8
14	.....do	1.30	7.0
25	.....do	1.46	16.0
June 3	.....do	1.60	24.2
July 4	.....do	1.40	12.2
21	.....do	1.30	7.7
Sept. 24	.....do	1.00	1.5
1909.			
July 6	N. O'Daniels	.90	48
14	.....do	.50	21
22	.....do	.40	14
31	.....do	.30	9
Aug. 7	.....do	.20	5
16	.....do	.20	5
25	.....do	.20	5

Daily gage height, in feet, of Elk Creek at mouth, near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	......	0.85	0.30	11	0.80	0.80	0.00	21	1.10	0.50	......
2	......	.80	.30	12	1.00	.75	.00	22	.93	.50	0.20
3	......	.75	.25	13	1.05	.75	......	23	.90	.45	......
4	......	.75	.25	14	1.05	.70	.20	24	.90	.45	......
5	0.92	.70	.50	15	1.00	.70	......	25	1.00	.45	......
6	......	.70	.20	16	1.05	.55	......	26	.95	.40	......
7	......	.75	.00	17	1.00	.55	.20	27	1.00	.50	.15
8	.90	.80	.00	18	1.05	.50	......	28	.85	.35	......
9	......	.80	.25	19	1.05	.50	......	29	.85	.38	......
10	1.00	.80	.00	20	1.10	.50	......	30	.85	.35	......
								31	......	.33	......

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	1.20	1.58	1.40	1.30	1.04	0.98	16	1.32	1.80	1.30	1.23	1.02	......
2	1.23	1.59	1.40	1.30	1.04	.98	17	1.34	1.70	1.30	1.20	1.02	......
3	1.26	1.60	1.40	1.30	1.03	.98	18	1.36	1.80	1.30	1.18	1.02	......
4	1.29	1.61	1.40	1.29	1.03	.98	19	1.37	1.60	1.30	1.16	1.02	......
5	1.33	1.62	1.40	1.29	1.02	.98	20	1.39	1.60	1.30	1.14	1.02	......
6	1.38	1.63	1.40	1.29	1.02	.98	21	1.41	1.60	1.30	1.12	1.02	......
7	1.40	1.64	1.40	1.28	1.02	.98	22	1.43	1.60	1.30	1.10	1.02	......
8	1.38	1.66	1.40	1.28	1.02	.98	23	1.45	1.60	1.30	1.08	1.02	......
9	1.36	1.68	1.40	1.28	1.02	.99	24	1.47	1.57	1.30	1.06	1.02	......
10	1.34	1.69	1.40	1.28	1.02	1.00	25	1.48	1.53	1.30	1.04	1.01	......
11	1.32	1.70	1.40	1.28	1.02	1.00	26	1.49	1.50	1.30	1.04	1.01	......
12	1.32	1.72	1.40	1.28	1.02	1.00	27	1.49	1.49	1.30	1.04	1.00	......
13	1.31	1.73	1.30	1.28	1.02	1.00	28	1.50	1.48	1.30	1.04	1.00	......
14	1.30	1.75	1.35	1.27	1.02	1.00	29	1.52	1.47	1.30	1.04	1.00	......
15	1.31	1.78	1.35	1.25	1.02	......	30	1.54	1.45	1.30	1.04	......	......
							31	1.58	.....	1.30	1.04	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	......	......	0.20	......	......	16	......	0.20	......	......	......
2	......	......	......	0.10	......	17	0.40	......	......	......	......
3	......	......	......	.10	......	18	......	......	......	0.10	......
4	......	......	......	.10	0.10	19	......	.30	......	......	......
5	......	......	......	......	......	20	......	......	......	......	......
6	0.90	......	.20	......	.10	21	......	......	0.15	......	......
7	......	0.20	......	......	......	22	.40	......	......	......	......
8	......	......	......	......	......	23	......	......	......	.10	......
9	......	......	......	......	.10	24	......	......	......	......	......
10	......	......	.20	......	......	25	......	.20	.15	......	......
11	......	......	......	......	......	26	.40	......	......	......	......
12	......	......	......	......	......	27	......	......	......	.10	......
13	......	......	......	.10	......	28	......	.20	......	......	......
14	.50	......	......	......	......	29	......	......	......	......	......
15	......	......	......	......	......	30	......	......	......	.10	......
						31	.30	......	......	......	......

Daily discharge, in second-feet, of Elk Creek at mouth, near Fraser, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	26	26	4	11	24	24	2	21	37	12	2
2	26	24	4	12	33	22	2	22	28	12	2
3	27	22	2	13	35	22	2	23	27	10	2
4	27	22	2	14	35	19	2	24	27	10	2
5	28	19	12	15	33	19	2	25	33	10	2
6	27	19	2	16	35	14	2	26	30	8	2
7	27	22	1	17	33	14	2	27	33	12	2
8	27	24	1	18	35	12	2	28	26	6	1
9	30	24	2	19	35	12	2	29	26	7	1
10	33	24	2	20	37	12	2	30	26	6	1
								31	......	5	1

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	4	24	12	7	1	1	16	8	49	7	5	1	......
2	5	25	12	7	1	1	17	9	35	7	4	1	......
3	6	25	12	7	1	1	18	10	49	7	4	1	......
4	7	26	12	7	1	1	19	10	25	7	3	1	......
5	8	27	12	7	1	1	20	11	25	7	3	1	......
6	11	28	12	7	1	1	21	12	25	7	3	1	......
7	12	29	12	7	1	1	22	13	25	7	2	1	......
8	11	31	12	7	1	1	23	14	25	7	2	1	......
9	10	34	12	7	1	1	24	16	23	7	2	1	......
10	9	35	12	7	1	1	25	17	20	7	2	1	......
11	8	35	12	7	1	1	26	17	18	7	2	1	......
12	8	38	12	7	1	1	27	17	17	7	2	1	......
13	8	39	7	7	1	1	28	18	17	7	2	1	......
14	7	42	9	6	1	1	29	19	16	7	2	1	......
15	8	47	9	6	1	......	30	20	14	7	2	1	......
							31	24	......	7	2	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	54	9	5	2	2	16	17	5	5	2	....
2	54	9	5	2	2	17	14	5	2.5	2	....
3	51	9	5	2	2	18	14	7	2.5	2	....
4	51	7	5	2	2	19	14	9	2.5	2	....
5	48	7	5	2	2	20	14	9	2.5	2	....
6	48	5	5	2	2	21	14	7	2.5	2	....
7	44	5	5	2	2	22	14	5	2.5	2	....
8	41	5	5	2	2	23	14	5	2.5	2	....
9	38	5	5	2	2	24	14	5	2.5	2	....
10	35	5	5	2	2	25	14	5	2.5	2	....
11	31	5	5	2	2	26	14	5	2.5	2	....
12	28	5	5	2	2	27	14	5	2.5	2	....
13	24	5	5	2	2	28	14	5	2.5	2	....
14	21	5	5	2	2	29	11	5	2.5	2	....
15	21	5	5	2	....	30	11	5	2	2	....
						31	9	5	....	2	....

NOTE.—Discharges interpolated for days on which gage was not read.

Monthly discharge of Elk Creek at mouth, near Fraser, Colo., for 1907-1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	37	24	30	1,810
July	26	5	16	988
August	12	1	2	140
1908.				
May	24	4	11.5	707
June	49	14	28.9	1,720
July	12	7	9.1	560
August	7	2	4.7	289
September	1	1	1.0	60
Oct. 1-14	1	1	1.0	28
1909.				
July	54	9	26.0	1,600
August	9	5	5.90	363
September	5	2	3.82	227
October	2	2	2.0	123
Nov. 1-14	2	2	2.0	56

ST. LOUIS CREEK AT UPPER STATION NEAR FRASER, COLO.

St. Louis Creek is tributary to the Fraser River from the west, entering about 1 mile below the town of Fraser.

The upper station is about 6 miles above the mouth of the stream at an elevation of approximately 10,000 feet above the sea level. The drainage area is about 15 square miles.

The location and datum of the Lallie automatic gage remained constant while the station was maintained. The station was established April 30, 1908, and discontinued November 9, 1909.

Discharge measurements of St. Louis Creek at upper station near Fraser, Colo., in 1908-1909.

Date.	Hydrographer.	Gage height.	Discharge.
1908.		*Feet.*	*Sec.-ft.*
Apr. 30	Stanley Krajicek	0.90	11.8
May 9	.....do	1.15	27.0
16	.....do	1.20	28.6
22	.....do	1.30	40.1
30	.....do	.90	11.9
June 3	.....do	1.50	64.1
11	.....do	2.35	137
22	.....do	3.75	294
July 3	.....do	2.20	121
16	.....do	1.95	91.8
30	.....do	1.59	63.2
Aug. 8	.....do	1.40	42.7
30	.....do	1.20	30.4
Sept. 6	.....do	1.15	33.2
6	.....do	1.25	35.7
20	.....do	1.10	27.8
Oct. 9	.....do	1.15	26.5
1909.			
July 14	N. O'Daniels	1.45	134
17	.....do	1.35	122
22	.....do	1.20	103
31	.....do	.80	62
Aug. 7	.....do	.65	50
16	.....do	.50	40
19	.....do	.70	54
28	.....do	.55	43
Sept. 25	.....do	.35	30
Oct. 13	.....do	.20	23
20	.....do	.20	23

Daily gage height, in feet, of St. Louis Creek at upper station near Fraser, Colo., for 1908–9.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	1.41	2.43	1.72	1.20	1.08	16	2.86	1.95	1.33	1.10	....
2	1.47	2.34	1.64	1.20	1.05	17	2.83	1.88	1.35	1.10	....
3	1.90	2.17	1.58	1.20	1.05	18	2.80	1.83	1.40	1.10	....
4	2.06	2.27	1.50	1.20	1.05	19	2.66	1.80	1.37	1.10	....
5	2.03	2.23	1.45	1.20	1.04	20	2.66	1.78	1.46	1.10	....
6	1.98	2.19	1.45	1.20	1.03	21	2.55	1.75	1.45	1.08	....
7	1.77	2.14	1.45	1.15	1.02	22	2.97	1.75	1.45	1.07	....
8	1.70	2.10	1.35	1.15	.90	23	2.97	1.77	1.50	1.08	....
9	1.72	2.12	1.35	1.15	1.00	24	2.75	1.71	1.45	1.07	....
10	2.05	2.12	1.35	1.15	1.00	25	2.91	1.65	1.45	1.08	....
11	2.05	2.10	1.40	1.15	1.00	26	2.91	1.65	1.45	1.08	....
12	2.12	2.10	1.45	1.15	1.00	27	2.88	1.65	1.47	1.08	....
13	2.97	2.10	1.55	1.20	.90	28	2.61	1.60	1.29	1.08	....
14	2.79	2.02	1.40	1.15	.80	29	2.61	....	1.29	1.05	....
15	2.71	2.02	1.35	1.10	....	30	2.35	1.58	1.24	1.05	....
						31	....	1.70	1.20	....	....

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	....	....	0.50	....	....	16	....	0.55	0.45	0.20	....
2	....	....	.50	0.30	0.30	17	1.35	.80	.45	.20	....
3	2.60	....	.45	.30	....	18	1.35	.80	....	.20	....
4	....	....	.40	.30	....	19	1.40	.70	....	.10	....
5	....	....	....	.30	....	20	1.35	.60	....	.10	....
6	....	....	....	....	.20	21	1.35	.55	.35	....	....
7	....	....	....	....	....	22	1.25	.55	.35	....	....
8	....	....	....	....	....	23	1.40	.55	.35	....	....
9	1.95	....	....	.90	.35	24	1.40	.60	.35	....	....
10	....	....	.50	.40	....	25	1.30	.50	.35	....	....
11	....	....	.50	.40	....	26	1.10	.50	.35	.20	....
12	....	....	.50	.30	....	27	....	.45	.30	....	....
13	....	....	.50	.20	....	28	....	.50	.30	....	....
14	1.45	0.55	.50	.20	....	29	....	.50	.30	....	....
15	....	.50	.45	.20	....	30	....	.55	....	.55	....
						31	.80	.60	....	....	....

Daily discharge, in second-feet, of St. Louis Creek at upper station near Fraser, Colo., for 1908–9.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	49	141	74	34	24	16	187	94	42	27	....
2	53	132	67	34	24	17	186	88	44	27	....
3	89	115	63	34	24	18	180	83	48	27	....
4	105	125	56	34	24	19	166	81	46	27	....
5	102	121	52	34	24	20	166	79	53	27	....
6	98	117	52	34	23	21	153	76	52	26	....
7	78	112	52	30	22	22	200	76	52	25	....
8	72	108	44	30	18	23	200	78	56	26	....
9	74	110	44	30	20	24	175	73	52	25	....
10	107	110	44	30	20	25	193	68	52	26	....
11	107	108	48	30	20	26	193	68	52	26	....
12	110	108	52	30	20	27	188	68	53	26	....
13	200	108	60	34	18	28	160	64	40	26	....
14	179	100	48	30	18	29	160	63	40	24	....
15	171	100	44	27	....	30	133	62	37	24	....
						31	....	72	34	....	....

Daily discharge, in second-feet, of St. Louis Creek at upper station near Fraser, Colo., for 1908-9—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	264	54	40	28	28	16	129	43	36	23	....
2	254	54	40	28	28	17	122	62	36	23	....
3	242	46	36	28	28	18	122	62	36	23	....
4	232	43	33	28	25	19	129	54	33	18	....
5	221	43	40	28	25	20	122	46	33	18	....
6	212	43	33	33	23	21	122	43	30	21	....
7	202	43	33	40	25	22	110	43	30	23	....
8	194	40	33	54	28	23	129	43	30	28	....
9	182	40	33	71	30	24	129	46	30	28	....
10	174	40	40	33	30	25	115	40	30	25	....
11	166	40	40	33	28	26	92	40	30	23	....
12	155	40	40	28	28	27	86	36	28	28	....
13	140	43	40	23	28	28	81	40	28	33	....
14	134	43	40	23	28	29	76	40	28	40	....
15	129	40	36	23	....	30	71	43	28	43	....
						31	62	46	....	43	....

NOTE.—Discharge interpolated for days on which gage was not read.

Monthly discharge of St. Louis Creek at upper station near Fraser, Colo., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
June	200	49	141	8,390
July	141	62	93.8	5,770
August	74	34	50.1	3,080
September	34	24	28.8	1,710
Oct., 1-14	24	18	21.4	594
1909.				
July	264	62	148	9,100
August	62	36	44.5	2,740
September	40	28	34.1	2,030
October	71	18	30.4	1,870
Nov. 1-14	30	23	27.3	758

ST. LOUIS CREEK AT LOWER STATION NEAR FRASER, COLO.

This station, which was established June 3, 1907, and discontinued November 9, 1909, is located about 1 mile above the mouth of the stream at an elevation of about 8,600 feet above sea level. The drainage area is about 19 square miles.

The stream forks near its junction with the Fraser and enters that stream in two channels. This fact was overlooked when the station was first established in 1907, and so the discharge of a smaller channel was not included in the results obtained that year. These have not been published. In the spring of 1908 a new gage was established at a new datum and shows the entire flow. The datum of the gage was changed on September 21, 1909. Data collected in 1907 are not published, as they are not comparable with those for 1908 and 1909.

Discharge measurements of St. Louis Creek at lower station near Fraser, Colo., in 1908-9.

Date.	Hydrographer.	Gage height.	Discharge.
1908.		*Feet.*	*Sec.-feet.*
May 23	Stanley Krajicek	0.42	52.3
31	do	.68	81.8
June 6	do	.73	97.1
11	do	1.03	148
17	do	1.03	148
July 3	do	.96	141
7	do	.8	110
20	do	.61	73.0
27	do	.50	51.1
Aug. 15	do	.37	41.0
Sept. 10	do	.20	30.8
18	do	.23	25.8
23	do	.20	24.2
1909.			
July 9	N. O'Daniels	1.10	182
14	do	.90	114
17	do	.80	94
22	do	.75	87
31	do	.50	60
Aug. 7	do	.45	55
16	do	.40	49
Sept. 25	do	.40	39
Oct. 13	do	.25	33
20	do	.20	31

NOTE.—Gage heights for 1909 are not comparable with those for 1908. Beginning Sept. 25, 1909, the gage datum was changed again.

Mean daily gage height, in feet, of St. Louis Creek at lower station near Fraser, Colo., for 1908-9.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	0.67	1.40	0.71	0.45	0.15	16	1.03	0.66	0.48	0.26	
2	.68	1.20	.77	.45	.15	17	1.03	.65	.48	.23	
3	.69	.96	.81	.45	.15	18	1.10	.64	.48	.23	
4	.70	.97	.87	.45	.15	19	1.18	.62	.48	.23	
5	.71	.98	.92	.45	.15	20	1.25	.61	.47	.22	
6	.73	99	.97	45	.15	21	1.32	.60	.47	.21	
7	.79	1.01	1.02	.45	.15	22	1.4	.58	.47	.20	
8	.85	.96	.85	.46	.15	23	1.4	.57	.47	.20	
9	.91	.90	.66	.46	.15	24	1.4	.55	.47	.20	
10	.97	.85	.47	.46	.15	25	1.4	.54	.47	.20	
11	1.08	.78	.47	.43	.15	26	1.4	.52	.47	.21	
12	1.03	.72	.47	.40	.15	27	1.4	.50	.46	.21	
13	1.03	.71	.47	.36	.15	28	1.4	.57	.46	.21	
14	1.03	.69	.47	.33	.15	29	1.4	.61	.45	.21	
15	1.03	.68	.48	.30		30	1.4	.67	.45	.21	
						31		.71	.45		

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1		0.50	0.40			16		0.40			
2				0.30	0.30	17					
3				.30		18	0.80				
4						19		.50			
5						20				0.20	
6			.40		.20	21			0.40		
7		.45				22					
8	1.10					23	.70			.30	
9				.50	.30	24					
10						25		.40	.40		
11						26				.20	
12						27					
13				.25		28		.40	.35		
14		.40				29					
15	.85					30				.40	
						31	.50				

NOTE.—Gage heights for 1909 are not comparable with those for 1908. Beginning Sept. 25, a new gage datum used.

Daily discharge, in second-feet, of St. Louis Creek at lower station near Fraser, Colo., for 1908–9.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1908.						1908.					
1	80	270	86	47	21	16	150	76	52	29	....
2	82	200	95	47	21	17	150	74	52	26	....
3	84	135	102	47	21	18	170	72	52	26	....
4	86	137	115	47	21	19	195	70	52	26	....
5	88	139	125	47	21	20	220	68	49	25	....
6	89	142	135	47	21	21	245	66	49	25	....
7	100	146	158	47	21	22	270	64	49	24	....
8	110	134	110	49	21	23	270	62	49	24	....
9	122	122	77	49	21	24	270	60	49	24	....
10	140	110	51	49	21	25	270	58	49	24	....
11	150	98	51	45	21	26	270	56	49	25	....
12	150	86	51	42	21	27	270	53	49	25	....
13	150	84	51	38	21	28	270	63	48	25	....
14	150	81	51	35	21	29	270	68	47	25	....
15	150	79	52	32	....	30	270	77	47	25	....
						31	....	84	47	....	....

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	250	60	49	35	35	16	102	49	49	33	....
2	250	60	49	35	35	17	94	55	49	33	....
3	236	60	49	35	35	18	94	60	49	33	....
4	218	55	49	35	35	19	94	60	49	31	....
5	218	55	49	37	33	20	87	60	49	31	....
6	218	55	49	37	21	21	87	55	39	31	....
7	200	55	49	39	33	22	87	55	39	35	....
8	182	55	49	39	35	23	81	55	39	35	....
9	182	55	49	44	35	24	81	49	39	35	....
10	164	49	49	39	35	25	76	49	39	33	....
11	146	49	49	37	35	26	76	49	39	31	....
12	128	49	49	35	35	27	70	49	39	33	....
13	114	49	49	33	35	28	70	49	37	35	....
14	114	49	49	33	35	29	64	49	37	37	....
15	102	49	49	33	....	30	64	49	37	39	....
						31	60	49	....	39	....

NOTE.—Discharges interpolated for days when gage was not read.

Monthly discharge of St. Louis Creek at lower station near Fraser, Colo., for 1908–9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
June	270	80	176	10,500
July	270	53	97.9	6,020
August	158	47	67.7	4,160
September	49	25	34.9	2,080
Oct. 1-14	21	21	21.0	583
1909.				
July	250	60	129	7,930
August	60	49	53.1	3,260
September	49	37	45.5	2,710
October	44	31	35.2	2,160
Nov. 1-14	35	21	33.7	936

NORTH RANCH CREEK AT UPPER STATION NEAR ROLLINS PASS, COLO.

This station, which was established May 1, 1908, and discontinued November 9, 1909, is located at the foot of Rollins Pass, Colo., at an elevation of about 10,000 feet above sea level.

The approximate drainage area is 2 square miles. Records of gage height were obtained by the means of a Lallie float gage, the datum remaining constant during the maintenance of the station.

Discharge measurements of North Ranch Creek at upper station near Rollins Pass, Colo., in 1908-9.

Date.	Hydrographer.	Gage height.	Discharge.
1908.		*Feet.*	*Sec.-ft.*
May 8	Stanley Krajicek	1.54	2.4
17	do	1.72	7.0
19	do	1.86	12.2
June 8	do	1.93	20.2
20	do	2.20	26.3
July 7	do	1.74	8.2
19	do	1.74	8.1
27	do	1.74	9.2
Aug. 31	do	1.68	6.3
1909.			
July 13	N. O'Daniels	.70	10.5
Aug. 2	do	.60	6
6	do	.55	5
13	do	.55	5
18	do	.60	6
Sept. 2	do	.50	4

Daily gage height, in feet, of North Ranch Creek at upper station near Rollins Pass, Colo., for 1908-9.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	1.54	1.64	1.87	1.50	1.50	1.50	16	1.54	1.89	1.50	1.50	1.50	......
2	1.54	1.79	1.82	1.50	1.50	1.50	17	1.69	1.86	1.50	1.50	1.50	......
3	1.54	1.84	1.77	1.50	1.50	1.50	18	1.69	1.86	1.50	1.50	1.50	......
4	1.55	1.84	1.72	1.50	1.50	1.50	19	1.70	1.86	1.50	1.50	1.50	......
5	1.56	1.86	1.67	1.50	1.50	1.50	20	1.66	1.84	1.50	1.50	1.50	......
6	1.57	1.94	1.62	1.50	1.50	1.51	21	1.84	1.85	1.50	1.50	1.50	......
7	1.58	1.84	1.50	1.50	1.50	1.51	22	1.82	1.85	1.50	1.51	1.56	......
8	1.50	1.74	1.50	1.50	1.50	1.51	23	1.74	1.85	1.50	1.51	1.50	......
9	1.60	1.94	1.50	1.50	1.50	1.51	24	1.74	1.86	1.50	1.51	1.50	......
10	1.56	1.84	1.50	1.50	1.50	1.51	25	1.74	1.86	1.50	1.51	1.50	......
11	1.54	1.86	1.50	1.50	1.50	1.51	26	1.74	1.86	1.50	1.50	1.49	......
12	1.54	1.84	1.50	1.50	1.50	1.51	27	1.69	1.87	1.50	1.50	1.49	......
13	1.54	1.84	1.50	1.50	1.50	1.51	28	1.69	1.87	1.50	1.50	1.49	......
14	1.54	1.94	1.50	1.50	1.50	1.51	29	1.71	1.87	1.50	1.50	1.49	......
15	1.54	......	1.50	1.50	1.50	......	30	1.74	1.87	1.50	1.50	1.49	......
							31	1.78	......	1.50	1.50	......	......

Daily gage height, in feet, of North Ranch Creek at upper station near Rollins Pass, Colo., for 1908-9—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1			0.50	0.60		16	.65	.55	.60		
2		.60	.50	.60		17	.65	.60	.60		
3		.65	.50	.55		18	.65	.60			
4		.60	.50	.55	.40	19	.65	.70			
5		.55	.50	.55		20	.60	.55	.60		
6		.55	.55	.55		21	.60	.55	.60		
7		.55	.60	.55		22	.60	.60	.60		
8	.90	.55	.60	.50	.40	23		.60	.60		
9	.90	.55	.60			24		.60	.60		
10	.90	.60	.60			25		.60	.60	.50	
11	.85	.60	60			26		.55	.60		
12	.85	.60	.60	.50		27		.55	.60		
13	.70	.55	.60			28		.55	.60		
14	.70	.55	.60			29		.55	.60		
15	.70	.55	.60			30		.55	.60		
						31		.50			

Daily discharge, in second-feet, of North Ranch Creek at upper station near Rollins Pass, Colo., for 1908-9.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	3	5	4	2	2	2	16	5	14	2	2	2	
2	3	10	4	2	2	2	17	7	13	2	2	2	
3	3	12	4	2	2	2	18	7	13	2	2	2	
4	3	12	4	2	2	2	19	7	13	2	2	2	
5	3	13	4	2	2	2	20	6	12	2	2	2	
6	4	16	3	2	2	2	21	12	13	2	2	2	
7	4	12	2	2	2	2	22	11	13	2	2	2	
8	4	9	2	2	2	2	23	9	13	2	2	2	
9	4	16	2	2	2	2	24	9	13	2	2	2	
10	3	12	2	2	2	2	25	9	13	2	2	2	
11	3	13	2	2	2	2	26	9	13	2	2	2	
12	3	12	2	2	2	2	27	7	13	2	2	2	
13	3	12	2	2	2	2	28	7	13	2	2	2	
14	3	16	2	2	2	2	29	8	13	2	2	2	
15	3	15	2	2	2		30	9	13	2	2	2	
							31	10		2	2		

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	52	6	4	6	2	16	8	5	6	4	
2	52	6	4	6	2	17	8	6	6	4	
3	52	8	4	5	2	18	8	6	6	4	
4	46	6	4	5	2	19	8	10.5	6	4	
5	46	5	4	5	2	20	6	5	6	4	
6	46	5	5	5	2	21	6	5	6	4	
7	37	5	6	5	2	22	6	6	6	4	
8	37	5	6	4	2	23	6	6	6	4	
9	37	5	6	4	2	24	6	6	6	4	
10	37	6	6	4	2	25	6	6	6	4	
11	27	6	6	4	2	26	6	5	6	4	
12	27	6	6	4	2	27	6	5	6	4	
13	10.5	5	6	4	2	28	6	5	6	4	
14	10.5	5	6	4	2	29	6	5	6	4	
15	10.5	5	6	4		30	6	5	6	4	
						31	6	4		4	

NOTE.—Discharges estimated for days in which gage was not read.

Monthly discharge of North Ranch Creek at upper station near Rollins Pass, Colo., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
May	12	3	5.8	357
June	16	5	12.7	756
July	4	2	2.4	148
August	2	2	2.0	123
September	2	2	2.0	119
Oct. 1-14	2	2	2.0	56
1909.				
July	52	6	20.4	1,250
August	10.5	4	5.6	344
September	6	4	5.6	333
October	6	4	4.3	264
November	2	2	2.0	56

NORTH RANCH CREEK AT LOWER STATION NEAR ROLLINS PASS, COLO.

This station, which was established June 3, 1907, and discontinued November 9, 1909, is located near Rollins Pass, about 4 miles below the upper station, and just above its junction with Middle Ranch Creek. The drainage area is about 5 square miles.

The datum of the rod gage remained constant during the maintenance of the station.

Discharge measurements of North Ranch Creek at lower station near Rollins Pass, Colo., in 1907-9.

Date.	Hydrographer.	Gage height.	Discharge.
1907.		*Feet.*	*Sec.-ft.*
June 4	G. M. Bull	0.80	23.3
9	.....do	1.15	38.
14	.....do	1.80	76.
26	.....do	1.95	92.
July 3	.....do	1.70	75.
14	.....do	1.15	43.
Aug. 5	.....do	.45	12.
13	.....do	.20	8.2
20	.....do	.10	4.8
1908.			
May 17	Stanley Krajicek	1.30	8.4
June 8	.....do	1.75	30.6
July 4	.....do	1.57	20.9
11	.....do	1.33	15.1
Aug. 12	.....do	1.00	8.0
31	.....do	1.77	5.0
Sept. 29	.....do	.81	4.1
1909.			
July 8	N. O'Daniels	1.40	58.
13	.....do	1.00	39.
Aug. 2	.....do	.40	13.
6	.....do	.30	10.
13	.....do	.30	10.

Daily gage height, in feet, of North Ranch Creek at lower station near Rollins Pass, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1			0.55	11	1.15			21	1.7		
2				12		1.1	0.2	22	1.8		
3	0.8	1.7	.5	13			.2	23			
4	.8			14	1.8	1.15		24			
5		1.5	.45	15	1.8			25			
6				16				26	1.95		
7			.4	17	1.7			27			
8	1.15			18		.95		28	1.7		
9	1.15	1.3		19	1.8			29			
10	1.15	1.2	.3	20		.8	.1	30			
								31			

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	1.10	1.65	1.57	0.95	0.77	0.80	16	1.20	1.95	1.21	0.82	0.77	
2	1.10	1.80	1.57	.96	.77	.80	17	1.30	1.93	1.15	.75	.77	
3	1.10	1.85	1.57	.96	.77	.79	18	1.30	1.91	1.09	.75	.77	
4	1.10	1.87	1.57	.97	.77	.79	19	1.30	1.89	1.00	.75	.77	
5	1.10	1.87	1.55	.97	.77	.79	20	1.30	1.87	1.00	.75	.77	
6	1.10	1.95	1.53	.98	.77	.78	21	1.30	1.85	1.00	.75	.77	
7	1.10	1.85	1.51	.99	.77	.78	22	1.30	1.83	1.00	.75	.77	
8	1.10	1.75	1.49	.99	.77	.77	23	1.30	1.81	1.00	.75	.78	
9	1.10	1.85	1.47	1.00	.77	.76	24	1.31	1.79	1.00	.75	.78	
10	1.10	1.95	1.40	1.00	.77	.76	25	1.33	1.77	1.00	.76	.78	
11	1.10	2.05	1.33	1.00	.77	.75	26	1.34	1.75	1.00	.76	.79	
12	1.10	2.03	1.33	1.00	.77	.75	27	1.36	1.70	1.00	.76	.79	
13	1.10	2.01	1.33	1.00	.77	.75	28	1.38	1.66	.99	.77	.80	
14	1.10	1.99	1.33	1.00	.77	.75	29	1.40	1.62	.97	.77	.80	
15	1.15	1.97	1.27	.84	.77		30	1.43	1.57	.96	.77	.81	
							31	1.45		.95	.77		

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1						16					
2		0.40	0.30			17					
3				0.30		18		0.35			
4					0.10	19					
5						20					
6		.30				21		.40			
7			.40			22					
8					.10	23		.35	0.35		
9						24					
10			.30			25				0.20	
11						26		.30			
12				.25		27			.30		
13		.30				28					
14	1.00					29					
15						30		.25	.30		
						31	0.40				

Daily discharge, in second-feet, of North Ranch Creek at lower station near Rollins Pass, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	21	75	16	11	38	40	9	21	75	22	4
2	22	75	15	12	51	36	8	22	75	22	4
3	23	75	14	13	64	39	8	23	76	21	4
4	23	67	13	14	76	43	8	24	81	21	3
5	27	58	12	15	76	39	8	25	86	20	3
6	31	55	12	16	76	36	7	26	92	20	3
7	35	52	11	17	75	33	7	27	84	19	3
8	38	49	11	18	75	30	6	28	75	19	2
9	38	47	10	19	76	27	5	29	75	18	2
10	38	43	10	20	76	23	5	30	75	18	2
								31	......	17	2

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.													
1	10	25	23	7	5	5	16	12	37	12	5	5	......
2	10	31	23	7	5	5	17	15	36	11	4	5	......
3	10	33	23	7	5	5	18	15	35	11	4	5	......
4	10	33	23	8	5	5	19	15	35	8	4	5	......
5	10	34	22	8	5	5	20	15	34	8	4	5	......
6	10	37	22	8	5	5	21	15	33	8	4	5	......
7	10	33	21	8	5	5	22	15	32	8	4	5	......
8	10	29	20	8	5	5	23	15	31	8	4	5	......
9	10	33	19	8	5	4	24	15	31	8	4	5	......
10	10	37	18	8	5	4	25	16	30	8	5	5	......
11	10	42	16	8	5	4	26	16	29	8	5	5	......
12	10	41	16	8	5	4	27	17	27	8	5	5	......
13	10	40	16	8	5	4	28	17	26	8	5	5	......
14	10	39	16	8	5	4	29	18	24	8	5	5	......
15	11	38	14	6	5	......	30	18	22	7	5	5	......
							31	19	......	7	5	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.											
1	73	13	10	10	5.5	16	34	10	10	9	....
2	70.5	13	10	10	5.5	17	29.5	11.5	10	9	....
3	68	11.5	10	10	5.5	18	29.5	11.5	10	9	....
4	65.5	11.5	11.5	10	5.5	19	25	11.5	10	9	....
5	63	10	11.5	10	5.5	20	25	13	11.5	9	....
6	63	10	13	10	5.5	21	20.5	13	11.5	9	....
7	60.5	10	13	10	5.5	22	20.5	13	11.5	9	....
8	58	10	11.5	10	5.5	23	16.5	11.5	11.5	9	....
9	58	10	10	10	5.5	24	16.5	11.5	11.5	7.5	....
10	53.5	10	10	9	5.5	25	16.5	10	11.5	7.5	....
11	48.5	10	10	9	5.5	26	13	10	10	7.5	....
12	43.5	10	10	9	5.5	27	13	10	10	7.5	....
13	39	10	10	9	5.5	28	13	10	10	7.5	....
14	39	10	10	9	5.5	29	13	10	10	7.5	....
15	34	10	10	9	....	30	13	9	10	7.5	....
						31	13	9	....	7.5	....

NOTE.—Discharges estimated for days on which gage height was not read.

Monthly discharge of North Ranch Creek at lower station near Rollins Pass, Colo., for 1907-1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	92	21	59	3,550
July	75	17	37	2,320
August	16	2	7	454
1908.				
May	19	10	13.0	799
June	42	22	32.9	1,960
July	23	7	13.8	848
August	8	4	6.0	369
September	5	5	5.0	298
Oct. 1-14	5	4	4.6	128
1909.				
July	73	13	37.0	2,280
August	13	9	10.8	664
September	13	10	10.6	631
October	10	7.5	8.9	547
Nov. 1-14	5.5	5.5	5.5	153

MIDDLE RANCH CREEK AT UPPER STATION NEAR ARROW, COLO.

This station, which was established May 1, 1908, and discontinued November 8, 1909, is located 3 miles from Arrow, on the Colonial Wagon Road, at an elevation of about 10,000 feet above sea level. Its drainage area is about 2½ square miles, and there are no tributaries above, which could be designated.

The location and datum of the Lallie automatic gage remained the same while the station was maintained.

Discharge measurements of Middle Ranch Creek at upper station near Arrow, Colo., in 1908-1909.

Date.	Hydrographer.	Gage height.	Discharge.
1908.		*Feet.*	*Sec.-ft.*
May 7	Stanley Krajicek	0.73	2.6
19	....do	1.03	12.8
26	....do	.93	9.4
June 15	....do	1.93	46.9
20	....do	1.10	22.0
July 7	....do	.88	10.9
21	....do	.78	3.7
Aug. 31	....do	.50	.4
Sept. 22	....do	.55	.8
1909.			
July 19	N. O'Daniels	0.7	9.5
Aug. 2	....do	.60	6.5
6	....do	.55	5.5
13	....do	.50	5.0
18	....do	.55	5.5

Daily gage height, in feet, of Middle Ranch Creek at upper station near Arrow, Colo., for 1908-9.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	0.73	1.01	0.95	0.81	0.54	0.54	16	0.91	1.20	0.85	0.81	0.53	......
2	.73	1.02	.95	.81	.54	.54	17	.93	1.20	.85	.81	.52	......
3	.73	1.03	.95	.81	.54	.54	18	.95	1.20	.85	.83	.52	......
4	.73	1.14	.95	.81	.54	.54	19	.98	1.20	.85	.83	.51	......
5	.73	1.14	.95	.81	.54	.54	20	1.13	1.20	.85	.83	.51	......
6	.73	1.14	.93	.81	.54	.54	21	.96	.95	.74	.83	.50	......
7	.73	1.13	.93	.81	.54	.55	22	.99	.95	.74	.83	.51	......
8	.75	1.19	.85	.81	.54	.54	23	.93	.95	.74	.83	.51	......
9	.77	1.14	.85	.81	.54	.55	24	.93	.95	.74	.78	.51	......
10	.79	1.14	.85	.81	.54	.55	25	.93	.95	.74	.68	.52	......
11	.81	1.16	.85	.81	.54	.55	26	.93	.95	.74	.65	.52	......
12	.83	1.22	.85	.81	.55	.55	27	.93	.95	.74	.63	.53	......
13	.85	1.23	.85	.81	.55	.60	28	.88	.95	.81	.60	.53	......
14	.87	1.24	.85	.81	.55	.55	29	.88	.95	.81	.58	.54	......
15	.89	1.20	.85	.81	.53	......	30	.88	.95	.81	.58	.54	......
							31	1.01	......	.81	.58	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	....	....	0.50	0.60	....	16	....	0.50	....	0.55	....
2	....	0.60	.50	.60	....	17	....	.50	....	.55	....
3	....	.60	.50	.55	....	18	....	.55	....	.55	....
4	....	.60	.50	.55	0.60	19	0.70	.60	....	.55	....
5	....	.55	.50	.55	.60	20	.70	.60	0.55	.55	....
6	....	.55	.55	.55	....	21	.70	.60	....	.55	....
7	....	.55	.55	.55	....	22	.65	.55	....	.55	....
8	....	....	.55	.55	.60	23	.65	.55	....	.55	....
9	....	....	.55	.55	....	24	.70	.55	....	....	....
10	....	....	.55	.55	....	25	.65	.55	....	....	....
11	....	....	.55	.55	....	26	.60	.55	.60	....	....
12	....	....	....	.55	....	27	.60	.50	.60	.60	....
13	....	.50	....	.55	....	28	....	.50	.60	....	....
14	....	....	....	.55	....	29	....	.50	.60	....	....
15	....	.50	....	.55	....	30	....	.50	.60	....	....
						31	....	.50	....	....	....

Daily discharge, in second-feet, of Middle Ranch Creek at upper station near Arrow, Colo., for 1908-9.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	3	13	10	5	1	1	16	8	31	6	5	1	......
2	3	14	10	5	1	1	17	9	31	6	5	1	......
3	3	15	10	5	1	1	18	10	31	6	5	1	......
4	3	24	10	5	1	1	19	10	31	6	5	1	......
5	3	24	10	5	1	1	20	23	31	6	5	1	......
6	3	24	9	5	1	1	21	10	10	3	5	1	......
7	3	24	9	5	1	1	22	10	10	3	5	1	......
8	3	24	6	5	1	1	23	9	10	3	5	1	......
9	3	24	6	5	1	1	24	9	10	3	4	1	......
10	4	27	6	5	1	1	25	9	10	3	2	1	......
11	5	34	6	5	1	1	26	9	10	3	2	1	......
12	5	34	6	5	1	1	27	9	10	3	1	1	......
13	6	37	6	5	1	1	28	7	10	5	1	1	......
14	7	31	6	5	1	1	29	7	10	5	1	1	......
15	7	31	6	5	1	......	30	7	10	5	1	1	......
							31	13	......	5	1	......	......

Daily discharge, in second-feet, of Middle Ranch Creek at upper station near Arrow, Colo., for 1908-9—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	25.0	6.5	5.0	6.5	6.5	16	11.0	5.0	5.5	5.5	....
2	25.0	6.5	5.0	6.5	6.5	17	10.5	5.0	5.5	5.5	....
3	22.5	6.5	5.0	5.5	6.5	18	10.0	5.5	5.5	5.5	....
4	22.5	6.5	5.0	5.5	6.5	19	9.5	6.5	5.5	5.5	....
5	22.5	5.5	5.0	5.5	6.5	20	9.5	6.5	5.5	5.5	....
6	21.0	5.5	5.5	5.5	6.5	21	9.5	6.5	5.5	5.5	....
7	21.0	5.5	5.5	5.5	6.5	22	7.5	5.5	5.5	5.5	....
8	21.0	5.5	5.5	5.5	6.5	23	7.5	5.5	5.5	5.5	....
9	19.0	5.5	5.5	5.5	6.5	24	9.5	5.5	5.5	6.5	....
10	17.0	5.5	5.5	5.5	6.5	25	7.5	5.5	5.5	6.5	....
11	16.0	5.5	5.5	5.5	6.5	26	6.5	5.5	6.5	6.5	....
12	15.0	5.0	5.5	5.5	6.5	27	6.5	5.0	6.5	6.5	....
13	13.5	5.0	5.5	5.5	6.5	28	6.5	5.0	6.5	6.5	....
14	13.5	5.0	5.5	5.5	6.5	29	6.5	5.0	6.5	6.5	....
15	12.5	5.0	5.5	5.5	....	30	6.5	5.0	6.5	6.5	....
						31	6.5	5.0	....	6.5	....

NOTE.—Discharges estimated for days on which gage height was not read.

Monthly discharge of Middle Ranch Creek at upper station near Arrow, Colo., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
May	23	3	7.10	437
June	37	10	21.2	1,260
July	10	3	6.0	369
August	5	1	4.1	252
September	1	1	1.0	60
October 1-14	1	1	1.0	28
1909.				
July	25.0	6.5	13.5	830
August	6.5	5.0	5.55	341
September	6.5	5.0	5.58	332
October	6.5	5.5	5.76	354
November 1-14	6.5	6.5	6.5	180

MIDDLE RANCH CREEK AT LOWER STATION NEAR ARROW, COLO.

This station which was established June 4, 1907, and discontinued November 8, 1909, is situated about 3 miles below the upper station and just above the junction of the stream with North Ranch Creek. The drainage area is about 3½ square miles.

The datum and location of the rod gage remained constant while station was being maintained.

Discharge measurements of Middle Ranch Creek at lower station near Arrow, Colo., in 1907-1909.

Date.	Hydrographer.	Gage.	Discharge.
1907.		*Feet.*	*Sec. ft.*
June 4	G. M. Bull	1.35	18.5
9	....do	1.60	32
14	....do	2.00	64
July 10	....do	1.50	23
Aug. 1	....do	1.00	6.6
5	....do	1.00	6.1
13	....do	.95	4.3
20	....do	.90	3.6
1908.			
June 8	Stanley Krajicek	1.40	27.3
12	....do	1.65	33.7
July 4	....do	1.16	13.2
11	....do	1.05	9.8
27	....do	1.00	6.4
Aug. 12	....do	.90	5.3
Sept. 29	....do	.97	5.7
1909.			
July 13	N. O'Daniels	1.40	20
Aug. 2	....do	.95	9
6	....do	.90	8
13	....do	.90	8

Daily gage height, in feet, of Middle Ranch Creek at lower station near Arrow, Colo., for 1907-1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1			1.00	11	1.65			21	1.85		
2				12		1.40	0.95	22			
3	1.41	1.85	1.00	13			.95	23	1.95		
4	1.35			14	2.00	1.40		24			
5		1.70	1.00	15	2.00			25			
6				16				26	2.00		
7			1.00	17	1.90			27			
8	1.65			18		1.20		28	1.85		
9	1.60	1.55		19	1.95			29			
10	1.60	1.50	.95	20		1.15	.90	30			
								31			

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	1.20	1.40	1.36	0.98	0.70	0.60	16	1.20	1.60	1.05	0.90	0.70	......
2	1.20	1.40	1.32	.97	.70	.60	17	1.20	1.58	1.05	.90	.70	......
3	1.20	1.40	1.24	.96	.70	.60	18	1.20	1.56	1.05	.90	.70	......
4	1.20	1.40	1.16	.96	.70	.60	19	1.20	1.54	1.05	.90	.70	......
5	1.20	1.40	1.14	.96	.70	.60	20	1.20	1.52	1.05	.90	.70	......
6	1.20	1.40	1.12	.94	.70	.60	21	1.20	1.50	1.05	.90	.68	......
7	1.20	1.40	1.10	.93	.70	.60	22	1.20	1.48	1.05	.86	.66	......
8	1.20	1.40	1.07	.92	.70	.60	23	1.20	1.46	1.05	.82	.63	......
9	1.20	1.40	1.06	.92	.70	.60	24	1.18	1.44	1.05	.78	.61	......
10	1.20	1.40	1.05	.91	.70	.60	25	1.16	1.40	1.05	.74	.58	......
11	1.20	1.40	1.05	.91	.70	.60	26	1.13	1.40	1.05	.70	.56	......
12	1.20	1.40	1.05	.90	.70	.60	27	1.11	1.40	1.00	.70	.54	......
13	1.20	1.65	1.05	.90	.70	.60	28	1.09	1.40	.99	.70	.52	......
14	1.20	1.64	1.05	.90	.70	.60	29	1.06	1.40	.99	.70	.50	......
15	1.20	1.62	1.05	.90	.70	......	30	1.03	1.39	.98	.70	.50	......
							31	1.01	......	.98	.70	......	......

Daily gage height, in feet, of Middle Ranch Creek at lower station near Arrow, Colo., for 1907-1909—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1						16					
2		0.95	0.90			17					
3						18		0.90			
4					0.95	19					
5						20					
6		.90				21		.90			
7			.90			22					
8	1.65				1.10	23		.90	1.00		
9			.90			24					
10						25				0.95	
11						26		.90			
12				0.90		27			1.00		
13	1.40	.90				28					
14						29					
15						30		.90	.95		
						31					

Daily discharge, in second-feet, of Middle Ranch Creek at lower station near Arrow, Colo., for 1907-1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	19	48	6.6	11	35	22	4	21	48	12	3
2	20	48	7	12	45	20	4	22	53	11	3
3	21	48	7	13	55	20	4.3	23	58	11	3
4	18.5	43	7	14	64	20	4	24	60	10	3
5	22	37	6.1	15	64	18	4	25	62	10	3
6	26	35	7	16	50	16	4	26	64	9	3
7	30	33	7	17	54	14	4	27	56	9	3
8	35	31	6	18	56	13	4	28	48	8	3
9	32	28	5	19	58	13	4	29	48	8	3
10	32	23	4	20	53	12	3.6	30	48	7	3
								31	......	7	2

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	12	21	18	7	2.5	1.7	16	12	32	8	5	2.5	......
2	12	21	16	6	2.5	1.7	17	12	31	8	5	2.5	......
3	12	21	14	6	2.5	1.7	18	12	30	8	5	2.5	......
4	12	21	17	6	2.5	1.7	19	12	29	8	5	2.5	......
5	12	21	11	6	2.5	1.7	20	12	27	8	5	2.5	......
6	12	21	10	6	2.5	1.7	21	12	26	8	5	2.4	......
7	12	21	8	6	2.5	1.7	22	12	25	8	5	2.2	......
8	12	21	8	5	2.5	1.7	23	12	25	8	4	2.0	......
9	12	21	8	5	2.5	1.7	24	12	25	8	3	1.8	......
10	12	21	8	5	2.5	1.7	25	11	21	8	3	1.6	......
11	12	21	8	5	2.5	1.7	26	10	21	8	2	1.4	......
12	12	21	8	5	2.5	1.7	27	10	21	8	2	1.3	......
13	12	36	8	5	2.5	1.7	28	9	21	7	2	1.1	......
14	12	35	8	5	2.5	1.7	29	8	21	7	2	1.1	......
15	12	34	8	5	2.5	......	30	8	20	7	2	1.1	......
							31	7	......	7	2	......	......

Daily discharge, in second-feet, of Middle Ranch Creek at lower station near Arrow, Colo., for 1907–1909—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	31.5	9	8	9	9	16	17.5	8	8	8	....
2	31.5	9	8	9	9	17	16	8	8	8	....
3	30	9	8	9	9	18	14.5	8	8	9	....
4	30	9	8	9	9	19	13	8	9	9	....
5	30	8	8	9	10	20	13	8	9	9	....
6	28.5	8	8	9	10	21	13	8	9	9	....
7	28.5	8	8	9	12	22	11	8	9	9	....
8	28.5	8	8	9	12	23	11	8	10	9	....
9	26.5	8	8	8	12	24	12	8	10	9	....
10	25	8	8	8	12	25	11	8	10	9	....
11	23.5	8	8	8	12	26	9	8	10	9	....
12	21.5	8	8	8	10	27	9	8	10	9	....
13	20	8	8	8	10	28	9	8	10	9	....
14	20	8	8	8	9	29	9	8	9	9	....
15	18.5	8	8	8	....	30	9	8	9	9	....
						31	9	8	....	9	....

NOTE.—Discharges estimated for days on which gage was not read.

Monthly discharge of Middle Ranch Creek at lower station near Arrow, Colo., for 1907–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	64	19	45	2,690
July	48	7	21	1,290
August	7	2	5	270
1908.				
May	12	7	11.3	695
June	36	20	24.4	1,450
July	18	7	9.1	437
August	7	2	4.5	277
September	2.5	1.1	2.20	130
Oct., 1–14	1.7	1.7	1.70	47
1909.				
July	31.5	9	18.7	1,150
August	9	8	8.1	498
September	10	8	8.6	512
October	9	8	8.7	535
Nov., 1–14	12	9	10.4	289

SOUTH RANCH CREEK AT UPPER STATION NEAR ARROW, COLO.

This station, which was established May 1, 1908, and discontinued November 8, 1909, is located 2 miles from Arrow, on the Colonial wagon road, and at an elevation of about 10,000 feet above sea level. The drainage area is about 3 squares miles. The datum and location of the Lallie automatic gage remained constant while the station was being maintained.

Discharge measurements of South Ranch Creek at upper station near Arrow, Colo., in 1908–1909.

Date.	Hydrographer.	Gage height.	Discharge.
1908.		*Feet.*	*Sec.-ft.*
May 6	Stanley Krajicek	1.00	4.2
19	....do	1.75	33.2
26	....do	1.37	19.5
June 6	....do	1.32	16.3
20	....do	1.30	14.4
July 7	....do	1.07	7.5
19	....do	1.00	3.9
27	....do	.98	3.7
Aug. 31	....do	.85	1.8
Sept. 29	....do	.88	2.3
29	....do	.85	2.6
1909.			
July 19	N. O'Daniels	6.40	9
Aug. 2	....do	.30	6
6	....do	.25	5
13	....do	.20	4
18	....do	.20	4

Daily gage height, in feet, of South Ranch Creek at upper station near Arrow, Colo., for 1908–1909.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	1.00	1.25	1.15	0.97	0.81	0.84	16	1.30	1.45	1.04	0.92	0.85	......
2	1.00	1.25	1.15	.97	.82	.84	17	1.40	1.41	1.04	.92	.85	......
3	1.00	1.29	1.12	.95	.85	.84	18	1.40	1.38	1.00	.90	.85	......
4	1.00	1.30	1.11	.95	.85	.84	19	1.60	1.32	1.00	.90	.85	......
5	1.00	1.31	1.08	.95	.85	.84	20	1.33	1.30	1.00	.90	.85	......
6	1.00	1.33	1.08	.94	.85	.84	21	1.33	1.30	1.00	.90	.85	......
7	1.00	1.48	1.06	.94	.85	.84	22	1.33	1.30	1.00	.90	.85	......
8	1.00	1.42	1.08	.94	.85	.84	23	1.33	1.30	.98	.90	.85	......
9	1.00	1.42	1.08	.94	.85	.82	24	1.33	1.28	.98	.89	.82	......
10	1.00	1.50	1.08	.94	.85	.82	25	1.33	1.27	.98	.87	.83	......
11	1.00	1.51	1.08	.92	.85	.82	26	1.33	1.25	.98	.85	.84	......
12	1.45	1.52	1.08	.92	.85	.82	27	1.28	1.24	.98	.85	.83	......
13	1.40	1.51	1.08	.92	.85	.82	28	1.28	1.23	.97	.85	.82	......
14	1.40	1.49	1.08	.92	.85	.82	29	1.25	1.17	.97	.85	.84	......
15	1.30	1.47	1.05	.92	.85	......	30	1.24	1.17	.97	.85	.85	......
							31	1.24	......	.97	.84	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	......	......	0.20	......	......	16	......	......	......	0.25	......
2	......	0.30	.20	......	......	17	......	......	......	.25	......
3	......	.25	.20	0.25	......	18	......	0.20	......	.25	......
4	......	.25	.20	.25	0.20	19	......	......	......	.25	......
5	......	.25	.20	.25	......	20	......	......	......	.25	......
6	......	.25	.20	.25	......	21	......	.20	......	.25	......
7	......	.25	.25	.25	......	22	......	.20	......	.25	......
8	0.70	......	.20	.25	.20	23	......	.20	......	.25	......
9	......	......	.20	.25	......	24	......	.20	......	......	......
10	......	......	.20	.25	......	25	......	.20	......	......	......
11	......	......	.20	.25	......	26	......	.20	......	......	......
12	......	......	.20	.25	......	27	......	.20	0.25	.20	......
13	.55	.20	.20	.25	......	28	......	.20	......	......	......
14	......	......	......	.25	......	29	......	.20	......	......	......
15	......	......	......	.25	......	30	......	.20	.25	......	......
						31	0.30	.20	......	......	......

Daily discharge, in second-feet, of South Ranch Creek at upper station near Arrow, Colo., for 1908-9.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	5	12	8	3.9	1.3	1.7	16	13	20	5	2.9	1.8	......
2	5	12	8	3.9	1.4	1.7	17	17	18	5	2.9	1.8	......
3	5	13	8	3.8	1.8	1.7	18	17	17	3.9	2.5	1.8	......
4	5	13	7	3.8	1.8	1.7	19	27	14	3.9	2.5	1.8	......
5	5	14	6	3.8	1.8	1.7	20	14	13	3.9	2.5	1.8	......
6	5	14	6	3.0	1.8	1.7	21	14	13	3.9	2.5	1.8	......
7	5	20	6	3.0	1.8	1.7	22	14	13	3.9	2.5	1.8	......
8	5	18	6	3.0	1.8	1.7	23	14	13	3.8	2.5	1.8	......
9	5	18	6	3.0	1.8	1.4	24	14	13	3.8	2.4	1.4	......
10	5	22	6	3.0	1.8	1.4	25	14	12	3.8	2.1	1.5	......
11	5	22	6	2.9	1.8	1.4	26	14	12	3.8	1.8	1.7	......
12	20	23	6	2.9	1.8	1.4	27	13	11	3.8	1.8	1.5	......
13	17	22	6	2.9	1.8	1.4	28	13	11	3.7	1.8	1.4	......
14	17	22	6	2.9	1.8	1.4	29	12	9	3.7	1.8	1.4	......
15	13	21	6	2.9	1.8	......	30	11	9	3.7	1.8	1.8	......
							31	11	......	3.7	1.8	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	27	6	4	5	4	16	13	4	4	5	....
2	27	6	4	5	4	17	11	4	4	5	....
3	27	5	4	5	4	18	11	4	4	5	....
4	24.5	5	4	5	4	19	9	4	5	5	....
5	24.5	5	4	5	4	20	9	4	5	5	....
6	22.5	5	4	5	4	21	9	4	5	5	....
7	22.5	5	5	5	4	22	9	4	5	5	....
8	22.5	5	4	5	4	23	7.5	4	5	5	....
9	20	5	4	5	4	24	7.5	4	5	4	....
10	20	5	4	5	4	25	7.5	4	5	4	....
11	17.5	4	4	5	4	26	7.5	4	5	4	....
12	17.5	4	4	5	4	27	7.5	4	5	4	....
13	15	4	4	5	4	28	6	4	5	4	....
14	15	4	4	5	4	29	6	4	5	4	....
15	13	4	4	5	....	30	6	4	5	4	....
						31	6	4	....	4	....

NOTE.—Discharges estimated for days on which gage was not read.

Monthly discharge of South Ranch Creek at upper station near Arrow, Colo., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1908.				
May	27	5	11.4	701
June	23	9	15.5	922
July	8	3.7	5.17	318
August	3.9	1.8	2.74	168
September	1.8	1.3	1.71	102
Oct. 1-14	1.7	1.4	1.57	44
1909.				
July	27	6	14.5	892
August	6	4	4.39	270
September	5	4	4.43	264
October	5	4	4.74	291
Nov. 1-14	4	4	4.0	111

SOUTH RANCH CREEK AT LOWER STATION NEAR ARROW, COLO.

This station, which was established June 3, 1907, and discontinued November 8, 1909, is located about 2 miles below the upper station and just above the junction of the South Fork with the Middle Fork. The drainage area is about 5 square miles.

The datum and location of the rod gage remained constant while the station was being maintained.

Discharge measurements of South Ranch Creek at lower station near Arrow, Colo., in 1907–1909.

Date.	Hydrographer.	Gage height.	Discharge.
1907.		*Feet.*	*Sec.-ft.*
June 4	G. M. Bull	1.75	28
9	.....do	2.00	36
26	.....do	1.95	31
July 5	.....do	1.55	17.1
12	.....do	1.25	10.3
Aug. 5	.....do	.65	4.1
13	.....do	.55	2.7
20	.....do	.60	2.5
1908.			
June 12	Stanley Krajicek	1.60	18.2
July 4	.....do	.90	8.8
11	.....do	.70	4.9
27	.....do	.50	3.2
Aug. 31	.....do	.49	3.3
Sept. 8	.....do	.49	3.2
29	.....do	.50	1.3
1909.			
July 13	N. O'Daniels	.60	13
Aug. 2	.....do	.20	5
6	.....do	.15	4
13	.....do	.15	4

Daily gage height, in feet, of South Ranch Creek at lower station near Arrow, Colo., for 1907–1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1			0.7	11	2.05			21	2.0		
2				12		1.25	0.6	22			
3	1.75	1.6	.65	13			.55	23	2.0		
4	1.75			14	2.1	1.35		24			
5		1.55	.65	15	2.2			25			
6				16				26	1.95		
7			.6	17	2.15			27			
8	2.05			18		.9		28	1.8		
9	2.0	1.5		19	2.15			29			
10	2.0	1.35	.6	20		.85	.6	30			
								31			

Daily gage height, in feet, of South Ranch Creek at lower station near Arrow, Colo., for 1907-1909—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	1.50	1.15	1.00	0.50	0.49	0.49	16	1.50	1.48	0.60	0.50	0.48	......
2	1.50	1.22	.99	.50	.49	.49	17	1.52	1.45	.60	.50	.49	......
3	1.50	1.28	.96	.50	.49	.49	18	1.54	1.42	.60	.50	.49	......
4	1.50	1.34	.93	.50	.49	.49	19	1.56	1.39	.60	.50	.49	......
5	1.50	1.40	.90	.50	.49	.49	20	1.58	1.37	.60	.49	.49	......
6	1.50	1.47	.86	.50	.49	.49	21	1.59	1.33	.60	.49	.49	......
7	1.50	1.53	.82	.50	.49	.49	23	1.60	1.30	.60	.49	.49	......
8	1.50	1.60	.79	.50	.49	.49	23	1.50	1.27	.55	.49	.49	......
9	1.50	1.60	.76	.50	.49	.49	24	1.40	1.25	.55	.49	.49	......
10	1.50	1.60	.73	.50	.48	.49	25	1.30	1.23	.55	.49	.49	......
11	1.50	1.58	.70	.50	.48	.49	26	1.20	1.20	.55	.49	.49	......
12	1.50	1.58	.66	.50	48	.49	27	1.19	1.19	.55	.49	.49	......
13	1.50	1.55	.63	.50	.48	.49	28	1.18	1.18	.55	.49	.49	......
14	1.50	1.53	.60	.50	.48	.49	29	1.18	1.17	.55	.49	.49	......
15	1.50	1.50	.60	.50	.48	......	30	1.16	1.16	.55	.49	.49	......
							31	1.15	......	.55	.49	......	......

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1						16					
2		0.20	0.10			17					
3				0.25		18		0.20			
4					0.25	19					
5						20		.15			
6		.15				21					
7			.20			22					
8	0.80				.15	23		.15	0.30		
9			.15			24					
10			.15			25				0.25	
11						26		.10			
12				.25		27			.25		
13		.15				28					
14	.60					29					
15						30		.10	.25		
						31	0.20				

Daily discharge, in second-feet, of South Ranch Creek at lower station near Arrow, Colo., for 1907-1909.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1907.				1907.				1907.			
1	27	24	4	11	39	12	3	21	36	5	2
2	27	23	4	12	40	10	3	22	36	5	2
3	28	22	4	13	41	12	2.7	23	36	5	2
4	28	20	4	14	42	14	3	24	34	5	2
5	31	17	4.1	15	46	12	3	25	32	5	2
6	34	17	3	16	45	10	3	26	31	5	2
7	37	17	3	17	44	8	3	27	29	5	2
8	39	17	3	18	44	6	2	28	27	4	2
9	36	17	3	19	44	6	2	29	26	4	2
10	36	14	3	20	40	5	2.5	30	25	4	1
								31	......	4	1

Daily discharge, in second-feet, of South Ranch Creek at lower station near Arrow, Colo., for 1907-1909—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1908.							1908.						
1	15	12	8	3.2	3	3	16	15	16	4.2	3.2	3	......
2	15	13	8	3.2	3	3	17	16	15	4.2	3.2	3	......
3	15	14	8	3.2	3	3	18	17	15	4.2	3.2	3	......
4	15	14	7	3.2	3	3	19	17	15	4.2	3.2	3	......
5	15	15	7	3.2	3	3	20	18	16	4.2	3.1	3	......
6	15	16	7.6	3.2	3	3	21	18	14	4.2	3.1	3	......
7	15	18	6.5	3.2	3	3	22	18	13	4.2	3.1	3	......
8	15	19	6.5	3.2	3	3	23	16	12	4	3.1	3	......
9	15	19	6.5	3.2	3	3	24	14	12	4	3.1	3	......
10	15	19	5.4	3.2	3	3	25	13	12	4	3.1	3	......
11	15	18	5.4	3.2	3	3	26	11	12	4	3.1	3	......
12	15	18	5.4	3.2	3	3	27	11	11	4	3.1	3	......
13	15	17	4.5	3.2	3	3	28	11	11	4	3.1	3	......
14	15	17	4.2	3.2	3	3	29	11	11	4	3.1	3	......
15	15	16	4.2	3.2	3	......	30	10	11	4	3.1	3	......
							31	10	......	4	3.1	......	......

Day.	July.	Aug.	Sept.	Oct	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1909.						1909.					
1	26.5	5	3	6	6	16	13.5	4	4	6	......
2	26.5	5	3	6	6	17	11.5	5	5	6	......
3	25	5	3	6	6	18	11.5	5	5	6	......
4	25	5	3	6	6	19	11.5	5	5	6	......
5	23.5	4	3	6	6	20	10.5	4	5	6	......
6	23.5	4	4	6	5	21	10.5	4	6	6	......
7	21.5	4	5	6	5	22	9	4	6	6	......
8	21.5	4	5	6	4	23	9	4	6.5	6	......
9	21.5	4	4	6	4	24	7.5	4	6.5	6	......
10	20	4	4	6	4	25	7.5	3	6.5	6	......
11	18	4	4	6	4	26	6.5	3	6	6	......
12	16.5	4	4	6	4	27	6.5	3	6	6	......
13	15	4	4	6	4	28	6	3	6	6	......
14	15	4	4	6	4	29	5	3	6	6	......
15	13.5	4	4	6	......	30	5	3	6	6	......
						31	5	3	......	6	......

NOTE.—Discharges estimated for days on which gage was not read.

Monthly discharge of South Ranch Creek at lower station near Arrow, Colo., for 1907-1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
June	46	25	35	2,120
July	24	4	11	668
August	4	1	3	164
1908.				
May	18	10	14.5	892
June	19	11	14.7	875
July	8	4	5.15	317
August	3.2	3.1	3.16	194
September	3	3	3.0	179
Oct. 1-14	3	3	3.0	84
1909.				
July	26.5	5	14.5	892
August	5	3	4.0	246
September	6.5	3	4.75	283
October	6	6	6.0	369
Nov. 1-14	6	4	4.86	135

WILLIAMS FORK BASIN.

WILLIAMS FORK NEAR SULPHUR SPRINGS, COLO.

Williams Fork rises in the Williams River Mountains and flows northwestward, joining Grand River in the central part of Middle Park.

The gaging station was established July 25, 1904, to obtain data for use in connection with the development of the stream for power, storage, and irrigation. It is located near the mouth of the stream, at the wagon bridge on the ranch of F. A. Field, about 9 miles west of Hot Sulphur Springs, Colo. The nearest railroad point is Parshall, a station on the Denver, Northwestern & Pacific Railroad.

The drainage area is about 200 square miles.

The station is below all tributaries. A number of irrigation ditches divert water below the station, and it is possible that in the future a tunnel will divert water from the headwaters of Williams Fork to the headwaters of Clear Creek in the Platte drainage basin. Some work has been done toward the construction of a reservoir and power plant a couple of miles downstream from the station. (See Pl. IV, *A*.)

Springs keep the ice from getting very thick at this station, but slush ice occurs frequently throughout the winter. The morning readings are usually distorted as the result of ice at the gage, but the afternoon readings indicate the open-water stage closely.

No change has been made in the location or in the datum of the staff gage at the bridge during the maintenance of the station.

Results are satisfactory. During low stages in the winter the flow is constant, being nearly all from springs.

Discharge measurements of Williams Fork near Sulphur Springs, Colo., in 1909.

Date.	Hydrographers.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 11	C. L. Chatfield	26	42	3.20	44
Apr. 30	.....do	47	60	3.40	64
May 9	.....do	49	82	3.76	152
June 18	Chatfield and Snelson, jr.	54	139	5.00	1,110
Aug. 8	Freeman and Howe	48	91	3.62	145
Oct. 14	Woolsey and Urquhart	44	72.4	3.47	105

Daily gage height, in feet, of Williams Fork near Sulphur Springs, Colo., for 1909.

[F. A. Field, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.20	3.20	3.13	3.22	3.43	4.11	4.88	3.85	3.76	3.48	3.33	3.26
2	3.20	3.20	3.15	3.28	3.41	4.18	4.85	3.81	3.68	3.46	3.35	3.20
3	3.25	3.18	3.17	3.30	3.43	4.22	4.77	3.75	3.61	3.44	3.32	3.15
4	3.23	3.16	3.20	3.25	3.60	4.40	4.94	3.69	3.60	3.44	3.32	3.12
5	3.22	3.16	3.15	3.27	3.75	4.56	5.00	3.64	3.61	3.43	3.26	3.10
6	3.22	3.12	3.18	3.30	3.77	4.66	4.76	3.66	3.67	3.46	3.22	3.12
7	3.16	3.14	3.15	3.32	3.75	4.75	4.68	3.69	3.82	3.50	3.24	3.12
8	3.16	3.12	3.15	3.28	3.79	4.85	4.66	3.65	3.71	3.50	3.18	3.10
9	3.14	3.12	3.16	3.32	3.85	4.90	4.62	3.65	3.72	3.39	3.12	3.10
10	3.10	3.10	3.20	3.40	3.90	4.78	4.58	3.64	3.78	3.49	3.14	3.10
11	3.10	3.12	3.21	3.32	3.96	4.77	4.46	3.66	3.72	3.48	3.18	3.10
12	3.12	3.12	3.22	3.30	3.98	4.74	4.36	3.65	3.62	3.44	3.35	3.12
13	3.12	3.10	3.22	3.27	3.88	4.80	4.32	3.71	3.66	3.46	3.18	3.12
14	3.14	3.12	3.18	3.27	3.88	4.76	4.23	3.62	3.66	3.46	3.18	3.10
15	3.14	3.12	3.22	3.34	3.82	4.75	4.20	3.59	3.74	3.43	3.20	3.10
16	3.14	3.12	3.20	3.35	3.92	4.80	4.14	3.56	3.70	3.42	3.12	3.10
17	3.18	3.12	3.22	3.38	3.97	4.98	4.10	....	3.68	3.41	3.10	3.10
18	3.20	3.12	3.22	3.42	4.05	5.15	4.10	....	3.63	3.40	3.10	3.10
19	3.20	3.12	3.22	3.46	4.04	5.28	4.10	3.93	3.61	3.40	3.12	3.10
20	3.18	3.10	3.22	3.39	4.09	5.28	4.10	3.76	3.59	3.39	3.40	3.12
21	3.15	3.10	3.23	3.36	4.17	5.12	4.06	3.80	3.58	3.40	3.32	3.12
22	3.15	3.11	3.20	3.36	4.22	5.12	3.98	3.72	3.60	3.39	3.28	3.10
23	3.16	3.12	3.18	3.43	4.25	5.15	3.90	3.68	3.60	3.41	3.30	3.10
24	3.12	3.12	3.22	3.41	4.18	5.16	4.02	3.69	3.58	3.38	3.36	3.12
25	3.12	3.12	3.25	3.42	4.09	5.20	4.10	3.66	3.57	3.39	3.36	3.12
26	3.14	3.13	3.22	3.44	4.02	5.14	4.07	3.61	3.54	3.34	3.32	3.10
27	3.12	3.12	3.25	3.54	4.01	4.96	4.02	3.57	3.52	3.36	3.30	3.15
28	3.12	3.13	3.28	3.56	4.13	4.96	3.96	3.60	3.51	3.35	3.10	3.15
29	3.15	....	3.28	3.50	4.18	4.92	3.87	3.57	3.50	3.34	3.38	3.18
30	3.15	....	3.28	3.45	4.04	4.96	3.85	3.58	3.49	3.33	3.30	3.16
31	3.20	....	3.27	....	4.12	....	3.70	3.70	....	3.32	....	3.18

NOTE.—Ice conditions from Jan. 1 to Apr. 15 and from Nov. 11 to Dec. 31. The afternoon readings are given as the mean for the day during these ice periods, as they are less affected by ice.

Daily discharge, in second-feet, of Williams Fork near Sulphur Springs, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	44	44	36	47	69	306	985	230	195	111	84	75
2	44	44	38	55	66	348	955	214	166	107	88	68
3	51	42	40	58	69	374	875	191	143	103	83	63
4	48	39	44	51	104	510	1,050	169	140	103	83	60
5	47	39	38	54	148	656	1,110	153	143	101	75	58
6	47	34	42	58	155	755	865	159	162	107	70	60
7	39	37	38	61	148	848	786	169	218	115	73	60
8	39	34	38	55	162	952	767	156	176	115	66	58
9	37	34	39	61	184	1,000	729	156	180	94	60	58
10	32	32	44	75	204	879	692	153	202	113	62	58
11	32	34	45	61	230	868	588	159	180	111	66	58
12	34	34	47	58	239	837	510	156	146	103	88	60
13	34	32	47	54	196	900	480	176	159	107	66	60
14	37	34	42	54	196	858	420	146	159	107	66	58
15	37	34	47	65	173	848	400	138	187	101	68	58
16	37	34	44	56	213	905	367	130	172	99	60	58
17	42	34	47	61	235	1,090	345	175	166	97	58	58
18	44	34	47	68	274	1,270	345	219	150	95	58	58
19	44	34	47	75	269	1,410	345	264	143	95	60	58
20	42	32	47	62	295	1,410	345	195	138	94	96	60
21	38	32	48	58	342	1,240	325	210	135	95	83	60
22	38	33	44	58	374	1,240	286	180	140	94	78	58
23	39	34	42	69	395	1,270	250	166	140	97	80	58
24	34	34	47	66	348	1,280	305	169	135	92	89	60
25	34	34	51	68	295	1,320	345	159	132	94	89	60
26	37	36	47	71	258	1,260	330	143	125	86	83	60
27	34	34	51	91	253	1,070	305	132	120	89	80	63
28	34	36	55	95	318	1,070	277	140	118	88	58	63
29	38	....	55	82	348	1,030	238	132	115	86	92	66
30	38	....	55	73	269	1,070	230	135	113	84	80	64
31	44	....	54	....	312	....	172	172	....	83	....	66

NOTE. These discharges are based on rating curves applicable as follows: Jan. 1 to Apr. 15, not well defined; Apr. 16 to June 15 fairly well defined; June 16 to Dec. 31, well defined.

Monthly discharge of Williams Fork near Sulphur Springs, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	51	32	39.3	2,420	C.
February	44	32	35.3	1,960	C.
March	55	36	45.4	2,790	C.
April	95	47	64.0	3,810	B.
May	395	66	230	14,100	B.
June	1,410	306	962	57,200	A.
July	1,110	172	517	31,800	A.
August	264	130	169	10,400	A.
September	218	113	153	9,100	A.
October	113	83	98.9	6,080	A.
November	95	58	74.7	4,440	B.
December	75	58	60.7	3,730	B.
The year	1,410	32	204	148,000	

EAGLE RIVER BASIN.

EAGLE RIVER AT GYPSUM, COLO.

This station, which was established February 7, 1907, to replace the station at Eagle, a few miles above, is located at the highway bridge one-fourth mile north of the Denver & Rio Grande Railroad station at Gypsum. It was discontinued December 31, 1909.

Gypsum Creek, the only tributary of consequence, enters about one-eighth mile below the station. The drainage area above mouth of Gypsum Creek is about 800 square miles.

A number of ditches divert water for irrigation, but such ditches are small, as in most places the valley is narrow.

The stream is frozen along the edges during the winter, and some slush and anchor ice also forms, but the river usually remains open in midstream.

The location and datum of the chain gage on the highway bridge have remained the same during the maintenance of the station. Discharge measurements are made from the bridge.

The channel is permanent, but measurements are only fairly satisfactory because of the rough and rocky bottom. Winter records are affected by ice and are only fairly accurate.

Discharge measurements of Eagle River at Gypsum, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 12[a]	C. L. Chatfield	92	....	2.80	107
Mar. 14	.....do	80	138	2.35	120
Apr. 19	.....do	94	213	3.20	408
June 20[b]	W. H. Snelson, jr	96	632	7.72	5,720
July 14	.....do	96	342	4.52	1,300
July 24	W. B. Freeman	96	330	4.43	1,190
Aug. 8	W. H. Snelson, jr	96	255	3.60	564
Oct. 9	G. H. Russell	85	206	3.2	341

[a] Ice; made by wading.
[b] Subsurface velocity method used. Coefficient of 80 per cent. Stay line used.

Daily gage height, in feet, of Eagle River at Gypsum, Colo., for 1909.

[J. F. Greenland, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.9	2.45	2.5	2.5	3.2	4.4	6.3	3.7	3.8	3.0	2.8	2.8
2	2.75	2.5	2.5	2.5	3.1	4.45	6.3	3.6	3.75	3.0	2.8	2.8
3	2.7	2.6	2.55	2.5	3.0	4.5	6.5	3.6	3.7	3.0	2.8	2.8
4	2.7	2.6	2.7	2.5	3.15	5.7	6.55	3.5	3.7	3.0	2.8	2.8
5	2.65	2.55	2.65	2.5	3.55	6.2	6.4	3.5	3.7	3.0	2.8	2.8
6	2.6	2.55	2.5	2.5	3.85	6.6	6.05	3.45	3.8	2.95	2.8	2.8
7	2.65	2.55	2.5	2.5	3.95	6.55	5.7	3.75	3.95	2.95	2.8	2.8
8	2.65	2.55	2.5	2.5	4.00	6.8	5.4	3.55	4.0	2.95	2.75	2.8
9	2.6	2.5	2.5	2.5	3.95	6.65	5.4	3.7	3.85	3.0	2.75	2.8
10	2.6	2.5	2.5	2.5	3.95	6.6	5.1	3.75	3.7	3.05	2.8	2.8
11	2.55	2.45	2.45	2.55	4.2	6.4	5.0	3.8	3.6	3.05	2.8	2.8
12	2.8	2.45	2.45	2.6	4.3	6.35	4.8	3.8	3.5	3.0	2.8	2.8
13	2.5	2.4	2.5	2.6	4.0	6.4	4.5	3.8	5.5	3.0	2.8	2.8
14	2.5	2.4	2.45	2.6	4.05	6.4	4.5	3.7	3.5	3.0	2.75	2.8
15	2.45	2.4	2.45	2.6	4.0	6.3	4.5	3.55	3.5	2.95	2.8	2.8
16	2.4	2.4	2.45	2.65	4.2	6.35	4.5	3.45	3.5	2.95	2.8	2.8
17	2.4	2.4	2.6	3.15	4.05	6.25	4.4	3.45	3.45	2.95	2.8	2.8
18	2.4	2.4	2.5	3.2	4.4	6.2	4.4	4.1	3.4	2.95	2.8	2.8
19	2.4	2.4	2.5	3.2	4.65	6.55	4.45	4.4	3.4	2.95	2.8	2.8
20	2.4	2.4	2.5	3.15	4.85	7.40	4.5	4.15	3.4	2.95	2.8	2.8
21	2.4	2.4	2.55	3.05	4.95	6.65	4.3	3.7	3.4	2.95	2.8	2.8
22	2.45	2.4	2.55	2.9	5.4	6.35	4.2	3.6	3.35	2.9	2.8	2.8
23	2.45	2.45	2.55	2.85	5.45	6.75	4.2	3.65	3.3	2.9	2.8	2.75
24	2.4	2.45	2.5	2.9	5.35	6.95	4.35	3.65	3.3	2.9	2.8	2.75
25	2.35	2.45	2.5	3.05	4.7	6.9	4.25	3.65	3.25	2.9	2.8	2.75
26	2.4	2.5	2.5	3.2	4.6	6.75	4.1	3.5	3.2	2.9	2.8	2.75
27	2.4	2.5	2.5	3.25	4.75	6.75	4.05	3.55	3.1	2.85	2.8	2.75
28	2.4	2.5	2.5	3.45	5.3	6.5	3.95	3.55	3.1	2.85	2.8	2.75
29	2.4	......	2.5	3.4	5.5	6.35	4.0	3.6	3.1	2.85	2.8	2.75
30	2.4	......	2.5	3.3	4.95	6.4	4.0	3.65	3.1	2.8	2.8	2.75
31	2.35	......	2.5	......	4.7	......	4.0	3.85	......	2.8	......	2.75

NOTE.—Ice conditions from Jan. 1 to 14.

Daily discharge, in second-feet, of Eagle River at Gypsum, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	144	155	155	389	1,240	3,480	610	675	265	200	200
2	......	155	155	155	346	1,290	3,480	550	642	265	200	200
3	......	181	168	155	307	1,340	3,780	550	610	265	200	200
4	......	181	209	155	368	2,790	3,860	490	610	265	200	200
5	......	168	195	155	578	3,330	3,630	490	610	265	200	200
6	......	168	155	155	779	3,930	3,110	462	675	248	200	200
7	......	168	155	155	852	3,860	2,630	642	782	248	200	200
8	......	168	155	155	890	4,230	2,250	520	820	248	185	200
9	......	155	155	155	852	4,000	2,250	610	710	265	185	200
10	......	155	155	155	852	3,930	1,900	642	610	282	200	200
11	......	144	144	168	1,060	3,630	1,790	675	550	282	200	200
12	......	144	144	181	1,140	3,560	1,570	675	490	265	200	200
13	......	132	155	181	890	3,630	1,270	675	490	265	200	200
14	......	132	144	181	930	3,630	1,270	610	490	265	185	200
15	144	132	144	181	890	3,480	1,270	520	490	248	200	200
16	132	132	144	195	1,060	3,560	1,270	462	490	248	200	200
17	132	132	181	368	930	3,400	1,170	462	462	248	200	200
18	132	132	155	389	1,240	3,330	1,170	900	435	248	200	200
19	132	132	155	389	1,500	3,860	1,220	1,170	435	248	200	200
20	132	132	155	368	1,720	5,190	1,270	942	435	248	200	200
21	132	132	168	326	1,840	4,000	1,080	610	435	248	200	200
22	144	132	168	272	2,400	3,560	985	550	410	230	200	200
23	144	144	168	256	2,460	4,160	985	580	385	230	200	185
24	132	144	155	272	2,330	4,460	1,120	580	385	230	200	185
25	122	144	155	326	1,560	4,380	1,030	580	362	230	200	185
26	132	155	155	389	1,440	4,160	900	490	340	230	200	185
27	132	155	155	414	1,610	4,160	860	520	300	215	200	185
28	132	155	155	520	2,270	3,780	782	520	300	215	200	185
29	132	......	155	491	2,520	3,560	820	550	300	215	200	185
30	132	......	155	438	1,840	3,630	820	580	300	200	200	185
31	122	......	155	......	1,560	......	820	710	......	200	......	185

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 15 to June 4, well defined above a discharge of 100 second-feet. June 5 to Dec. 31, well defined between discharges of 300 and 1,800 second-feet. Jan. 1 to 14, ice conditions; daily discharge estimated at 110 second-feet.

Monthly discharge of Eagle River at Gypsum, Colo., for 1909.

nth.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	144	....	123	7,560	B.
February	181	132	148	8,220	A.
March	209	144	159	9,780	A.
April	520	155	262	15,600	A.
May	2,520	307	1,270	78,100	A.
June	5,190	1,240	3,570	212,000	A.
July	3,860	782	1,740	107,000	A.
August	1,170	462	611	37,600	A.
September	820	300	501	29,800	A.
October	282	200	246	15,100	A.
November	200	185	198	11,800	B.
December	200	185	196	12,100	B.
The year	5,190	....	752	545,000	

ROARING FORK BASIN.

DESCRIPTION.

Roaring Fork, which enters the Grand at Glenwood Springs, drains a large area lying chiefly in Pitkin County and reaching to the Continental Divide. It is one of the largest tributaries of the Grand. Frying Pan and Crystal rivers are its most important branches.

ROARING FORK NEAR EMMA, COLO.

This station, which is located on a steel highway bridge about 1½ miles below Emma, a station on the Aspen branch of the Denver & Rio Grande Railroad, was established July 19, 1908. It was discontinued September 30, 1909.

Frying Pan River joins Roaring Fork about 3 miles above the station, and Sopris Creek comes in above the station near Emma. The drainage area at the station is more than 500 square miles.

A few small ditches divert water above the station, principally for meadow irrigation. The only important power plant above the station is that at Aspen, Colo., which generates 1,000 horsepower.

The stream at this point is not so much affected by ice as at other stations in that vicinity, and the channel is frequently open during the winter. Slush ice is common.

A staff gage was used until August 27, 1908, at which time a chain gage was established on the bridge with a datum 0.10 foot above that of the staff gage. Gage heights are all referred to the datum of the chain gage.

Results at this station are satisfactory except when affected by ice during very severe winters.

Discharge measurements of Roaring Fork near Emma, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 16[a]	C. L. Chatfield	80	125	3.40	206
Mar. 19	.....do	100	133	3.50	225
Apr. 23	.....do	100	184	3.96	375
June 23	Wm. H. Snelson, jr	117	957	9.85	7,080
July 12	.....do	117	657	7.15	2,870
Aug. 7	.....do	104	402	5.30	939
Oct. 12	Russell and Weaver	64	249	4.50	586

[a] Open channel.

Daily gage height, in feet, of Roaring Fork near Emma, Colo., for 1909.

[W. R. Hood, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3.7	3.5	3.45	3.5	4.2	6.1	8.75	5.4	5.65
2	3.6	3.55	3.4	3.5	4.2	6.0	9.15	5.5	5.45
3	3.6	3.5	3.4	3.65	4.15	6.5	9.1	5.4	5.4
4	3.6	3.6	3.4	3.75	4.5	7.2	8.8	5.35	5.4
5	3.5	3.5	3.45	3.7	4.95	8.05	9.3	5.15	5.75
6	3.6	3.5	3.45	3.5	5.2	8.5	8.65	5.3	6.1
7	3.6	3.5	3.5	3.5	5.4	8.6	8.2	5.3	6.4
8	3.55	3.5	3.45	3.4	5.65	9.0	7.8	5.3	6.0
9	3.55	3.5	3.35	3.45	5.45	9.25	7.65	5.5	5.85
10	3.5	3.5	3.35	3.45	5.6	9.15	7.5	5.45	5.7
11	3.4	3.5	3.4	3.6	5.75	9.05	7.2	5.4	5.55
12	3.3	3.45	3.35	3.5	5.75	9.10	7.05	5.35	5.5
13	3.5	3.45	3.35	3.5	5.6	9.4	6.9	5.5	5.6
14	3.65	3.45	3.35	3.5	5.55	9.15	6.8	5.3	5.55
15	3.55	3.35	3.4	3.6	5.4	9.2	6.7	5.1	5.6
16	3.5	3.4	3.4	3.85	5.7	9.0	6.6	5.1	5.65
17	3.5	3.45	3.5	4.05	5.65	9.6	6.4	5.45	5.55
18	3.45	3.4	3.5	4.3	6.0	9.7	6.3	6.1	5.45
19	3.5	3.4	3.5	4.5	6.2	10.1	6.4	6.1	5.4
20	3.45	3.3	3.5	4.5	6.45	10.1	6.3	5.65	5.3
21	3.5	3.4	3.6	4.2	6.[illegible]5	9.85	6.2	5.7	5.2
22	3.5	3.45	3.6	4.05	6.75	9.75	6.2	5.45	5.15
23	3.5	3.4	3.6	3.9	6.85	9.6	6.3	5.4	5.1
24	3.4	3.4	3.55	3.95	6.7	9.7	6.25	5.5	5.1
25	3.4	3.45	3.55	4.0	6.25	9.7	6.2	5.4	5.0
26	3.4	3.4	3.55	4.3	6.25	9.4	6.05	5.2	4.9
27	3.5	3.3	3.6	4.55	6.6	9.35	6.1	5.2	4.8
28	3.5	3.35	3.6	4.65	7.0	9.15	5.9	5.1	4.85
29	3.45	....	3.55	4.55	7.05	8.95	5.7	5.35	4.75
30	3.35	....	3.55	4.3	6.2	8.95	5.6	5.5	4.7
31	3.5	....	3.6	....	6.15	....	5.5	5.85	....

NOTE.--Mush ice running during portions of January, February, and first few days of March. Effect on monthly means probably slight.

Daily discharge, in second-feet, of Roaring Fork near Emma, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	285	225	212	225	465	1,740	5,160	1,140	1,340
2	255	240	200	225	465	1,650	5,840	1,220	1,180
3	255	225	200	270	445	2,140	5,760	1,140	1,140
4	255	255	200	302	595	2,930	5,250	1,100	1,140
5	225	225	212	285	840	4,060	6,100	965	1,420
6	255	225	212	225	1,000	4,750	5,000	1,070	1,740
7	255	225	225	225	1,140	4,910	4,280	1,070	2,040
8	240	225	212	200	1,340	5,590	3,700	1,070	1,650
9	240	225	188	212	1,180	6,020	3,500	1,220	1,520
10	225	225	188	212	1,300	5,840	3,300	1,180	1,380
11	200	225	200	255	1,420	5,680	2,930	1,140	1,260
12	175	212	188	225	1,420	5,760	2,750	1,100	1,220
13	225	212	188	225	1,300	6,270	2,580	1,220	1,300
14	270	212	188	225	1,260	5,840	2,470	1,070	1,260
15	240	188	200	255	1,140	5,930	2,360	930	1,300
16	225	200	200	338	1,380	5,590	2,250	930	1,340
17	225	212	225	408	1,340	6,630	2,040	1,180	1,260
18	212	200	225	505	1,650	6,810	1,940	1,740	1,180
19	225	200	225	595	1,840	7,530	2,040	1,740	1,140
20	212	175	225	595	2,090	7,530	1,940	1,340	1,070
21	225	200	255	465	2,090	7,080	1,840	1,380	1,000
22	225	212	255	408	2,420	6,900	1,840	1,180	965
23	225	200	255	355	2,520	6,630	1,940	1,140	930
24	200	200	240	372	2,360	6,810	1,890	1,220	930
25	200	212	240	390	1,890	6,810	1,840	1,140	870
26	200	200	240	505	1,890	6,270	1,700	1,000	810
27	225	175	255	620	2,250	6,180	1,740	1,000	750
28	225	188	255	670	2,690	5,840	1,560	930	780
29	212	....	240	620	2,750	5,500	1,380	1,100	722
30	188	....	240	505	1,840	5,500	1,300	1,220	695
31	225	....	255	....	1,790	....	1,220	1,520	....

NOTE.—These discharges are based on a rating curve well defined between 150 and 7,500 second-feet.

Monthly discharge of Roaring Fork near Emma, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	285	175	227	14,000	B.
February	255	175	211	11,700	B.
March	255	188	221	13,600	A.
April	670	200	364	21,700	A.
May	2,750	445	1,490	91,600	A.
June	7,530	1,650	5,560	331,000	A.
July	6,100	1,220	2,890	178,000	A.
August	1,740	930	1,170	71,900	A.
September	2,040	695	1,180	70,200	A.
The period	....	....	....	804,000	

ROARING FORK AT GLENWOOD SPRINGS, COLO.

This station, which was established April 6, 1906, is located at the mouth of the stream on a single-span wooden road bridge, about 500 feet above the junction of Grand River and Roaring Fork, and about four blocks west of Grand Avenue, Glenwood Springs. It was discontinued September 30, 1909.

A number of small irrigation ditches divert water from the main stream and tributaries. Three important power plants, located on Crystal River, Yule Creek, and Maroon and Castle creeks, develop about 2,100 horsepower. A number of smaller plants are also in operation in this drainage area.

Surface ice rarely forms solid across the river at this station, although slush and anchor ice are common. Extremely high stages of Grand River may affect the flow at this station to a small degree.

Neither the location nor the datum of the chain gage on the bridge has been changed during the maintenance of the station.

As the stream bed is very rough conditions are unfavorable for accurate measurements. The channel is, however, fairly permanent, and the results are satisfactory.

Discharge measurements of Roaring Fork at Glenwood Springs, Colo., in 1909.

Date.		Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
			Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan.	13[a]	C. L. Chatfield	140	142	1.05	389
Mar.	16[a]	.....do	45	148	1.20	362
Apr.	21	.....do	55	291	2.00	1,010
June	21	Wm. H. Snelson, jr	179	1,200	7.46	10,500
	30	W. B. Freeman	172	1,030	6.68	8,410
July	13	Wm. H. Snelson, jr	166	601	4.25	3,370
Aug.	5	.....do	157	359	2.70	1,310
Oct.	10	G. H. Russell	153	292	2.25	908

[a] Slush ice in sections. Results rough.

Daily gage height, in feet, of Roaring Fork at Glenwood Springs, Colo., for 1909.

[Mrs. J. W. Johnson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.15	1.15	1.15	1.3	2.0	3.7	6.35	3.0	3.0
2	1.2	1.2	1.2	1.35	2.0	3.55	6.25	3.05	2.8
3	1.2	1.2	1.15	1.4	2.05	4.2	6.35	3.0	2.75
4	1.3	1.15	1.2	1.45	2.3	4.85	6.4	2.75	2.8
5	1.35	1.15	1.2	1.5	2.8	5.6	6.8	2.65	2.9
6	1.4	1.2	1.25	1.45	3.05	6.35	6.2	2.6	3.9
7	1.35	1.2	1.25	1.4	3.1	6.6	5.75	2.7	3.9
8	1.25	1.2	1.2	1.35	3.35	6.8	5.3	2.7	3.7
9	1.3	1.15	1.1	1.35	3.4	6.75	5.15	2.8	3.4
10	1.25	1.2	1.15	1.4	3.5	6.65	4.85	2.75	3.45
11	1.2	1.2	1.15	1.45	3.7	6.65	4.8	2.75	3.2
12	1.2	1.2	1.2	1.4	3.7	6.35	4.55	2.8	3.0
13	1.15	1.2	1.2	1.3	3.4	6.6	4.4	2.9	3.05
14	1.3	1.2	1.3	1.4	3.2	6.35	4.3	2.8	2.9
15	1.3	1.1	1.25	1.4	3.1	6.3	4.2	2.65	3.0
16	1.25	1.1	1.25	1.6	3.3	6.2	4.15	2.7	2.9
17	1.2	1.1	1.3	1.7	3.4	6.75	4.1	3.15	2.85
18	1.15	1.1	1.3	2.2	3.5	7.15	4.0	3.3	2.75
19	1.2	1.15	1.25	2.25	3.85	7.8	4.05	3.2	2.7
20	1.2	1.1	1.3	2.3	4.2	7.85	3.85	3.25	2.6
21	1.15	1.05	1.3	2.0	4.15	7.65	3.65	2.9	2.6
22	1.25	1.0	1.3	1.8	4.45	7.3	3.45	2.8	2.6
23	1.3	1.0	1.25	1.8	4.45	7.15	3.5	2.7	2.5
24	1.25	1.0	1.3	1.8	4.3	7.3	3.8	2.85	2.5
25	1.15	1.05	1.25	1.85	3.95	7.35	3.65	2.75	2.4
26	1.1	1.1	1.3	2.05	3.85	7.2	3.55	2.75	2.4
27	1.2	1.0	1.3	2.35	4.45	6.85	3.55	2.7	2.4
28	1.2	1.0	1.3	2.5	4.65	6.85	3.4	2.6	2.3
29	1.15	....	1.25	2.4	4.7	6.65	3.35	2.65	2.3
30	1.1	....	1.3	2.2	4.1	6.45	3.25	2.8	2.3
31	1.0	....	1.3	....	3.8	....	3.05	3.15	....

Note.—Probable ice conditions during January, February, and March.

Daily discharge, in second-feet, of Roaring Fork at Glenwood Springs, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	375	375	375	450	995	3,040	7,660	1,640	1,640
2	400	400	400	480	995	2,820	7,440	1,700	1,420
3	400	400	375	510	1,040	3,850	7,660	1,640	1,370
4	450	375	400	545	1,290	5,020	7,780	1,370	1,420
5	480	375	400	580	1,860	6,530	8,740	1,270	1,530
6	510	400	425	545	2,160	8,160	7,320	1,220	2,840
7	480	400	425	510	2,220	8,730	6,310	1,320	2,840
8	425	400	400	480	2,550	9,190	5,350	1,320	2,540
9	450	375	350	480	2,620	9,080	5,040	1,420	2,130
10	425	400	375	510	2,750	8,840	4,450	1,370	2,200
11	400	400	375	545	3,040	8,840	4,350	1,370	1,880
12	400	400	400	510	3,040	8,160	3,890	1,420	1,640
13	375	400	480	450	2,620	8,730	3,630	1,530	1,700
14	450	400	450	510	2,350	8,160	3,460	1,420	1,530
15	450	350	425	510	2,220	8,040	3,300	1,270	1,640
16	425	350	425	650	2,480	7,820	3,220	1,320	1,530
17	400	350	450	730	2,620	9,080	3,140	1,820	1,480
18	375	350	450	1,190	2,750	9,800	2,990	2,000	1,370
19	400	375	425	1,240	3,270	11,200	3,060	1,880	1,320
20	400	350	450	1,290	3,850	11,300	2,760	1,940	1,220
21	375	325	450	995	3,760	10,800	2,470	1,530	1,220
22	425	300	450	810	4,280	9,940	2,200	1,420	1,220
23	450	300	425	810	4,280	9,580	2,200	1,320	1,120
24	425	300	450	810	4,020	9,940	2,690	1,480	1,120
25	375	325	425	855	3,430	10,100	2,470	1,370	1,030
26	350	350	450	1,040	3,270	9,700	2,330	1,370	1,030
27	400	300	450	1,340	4,280	8,860	2,330	1,320	1,030
28	400	300	450	1,500	4,640	8,860	2,130	1,220	935
29	375	....	425	1,400	4,730	8,380	2,060	1,270	935
30	350	....	450	1,190	3,680	7,900	1,940	1,420	935
31	300	....	450	....	3,190	....	1,700	1,820	....

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 18, well defined. June 19 to Sept. 30, well defined.

Monthly discharge of Roaring Fork at Glenwood Springs, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	510	300	410	25,200	C.
February	400	300	362	20,100	C.
March	480	350	421	25,900	C.
April	1,500	450	782	46,500	A.
May	4,730	995	2,910	179,000	A.
June	11,300	2,820	8,350	497,000	B.
July	8,740	1,700	4,070	250,000	A.
August	2,000	1,220	1,480	91,000	A.
September	2,840	935	1,530	91,000	A.
The period	....	....	....	1,230,000	

FRYING PAN RIVER AT BASALT, COLO.

This station, which was established July 19, 1908, is located at the wooden highway bridge about 100 yards from the Colorado Midland Railroad depot and about 75 yards downstream from a concrete arch bridge in the town of Basalt. It was discontinued September 30, 1909.

This station is near the mouth of the stream and the records show the total run-off from the drainage basin.

Diversions above are limited to ditches for meadow irrigation. The stream affords good opportunities for power and storage development.

Heavy ice prevails during the winter months, and gage readings are at times distorted by the backwater caused by the freezing of the river below. Slush ice also interferes with the determination of discharge.

The location and datum of the staff gage at the bridge have remained unchanged during the maintenance of the station.

The accuracy of the measurements is affected by the roughness of the stream bed and the high current velocities during flood periods.

Discharge measurements of Frying Pan River at Basalt, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 16[a]	C. L. Chatfield	46.5	68	1.32	67
Mar. 19[a]	....do	46.5	75	1.40	76
Apr. 23	....do	54.7	92	1.80	147
June 23	Chatfield and Snelson, jr	62.5	252	4.50	2,080
July 12	W. H. Snelson, jr	60.8	178	3.25	760
Aug 6	....do	46.5	105	2.00	304
Oct. 12	Russell and Weaver	45.5	97.5	1.8	159

[a] Ice along edges.

Daily gage height, in feet, of Frying Pan River at Basalt, Colo., for 1909.

[J. G. Ould, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3.4	1.95	1.4	1.45	2.0	3.1	4.0	2.05	2.55
2	3.4	2.05	1.4	1.5	1.95	3.15	3.95	2.15	2.5
3	3.45	2.15	1.4	1.5	2.0	3.45	3.95	2.1	2.4
4	3.25	2.0	1.4	1.5	2.25	3.85	4.0	2.15	2.25
5	3.15	2.05	1.4	1.6	2.65	4.35	4.35	2.05	2.4
6	1.55	2.1	1.4	1.55	2.7	4.65	3.9	2.1	2.45
7	1.65	2.1	1.4	1.5	2.8	4.8	3.6	2.15	2.45
8	1.55	2.1	1.4	1.35	2.9	4.9	3.4	2.1	2.4
9	1.5	2.0	1.4	1.4	2.85	4.85	3.3	2.2	2.3
10	1.45	2.0	1.45	1.45	2.95	4.6	3.2	2.15	2.25
11	1.4	1.85	1.55	1.55	3.05	4.6	3.15	2.15	2.2
12	2.45	1.65	1.6	1.5	3.1	4.5	3.0	2.15	2.2
13	2.4	1.55	1.6	1.5	2.95	4.6	2.95	2.25	2.2
14	2.3	1.5	1.55	1.5	2.8	4.6	2.9	2.15	2.2
15	1.5	1.4	1.6	1.6	2.8	4.6	2.9	2.0	2.2
16	1.45	1.4	1.55	1.7	3.05	4.55	2.8	2.0	2.2
17	1.3	1.4	1.45	1.95	2.95	4.9	2.75	2.2	2.2
18	1.3	1.45	1.4	2.1	3.1	5.1	2.65	2.5	2.2
19	1.35	1.45	1.4	2.25	3.25	5.35	2.6	2.5	2.15
20	1.3	1.45	1.5	2.35	3.45	5.2	2.55	2.3	2.1
21	1.3	1.5	1.5	2.15	3.5	5.15	2.6	2.2	2.0
22	1.3	1.55	1.45	1.85	3.65	4.75	2.55	2.1	2.0
23	1.3	1.6	1.4	1.85	3.7	4.75	2.55	2.1	2.0
24	1.35	1.5	1.45	1.85	3.5	4.75	2.55	2.1	1.95
25	1.4	1.4	1.45	1.85	3.4	4.75	2.5	2.1	1.9
26	1.5	1.4	1.5	2.05	3.4	4.45	2.4	2.0	1.9
27	1.5	1.45	1.45	2.25	3.55	4.45	2.4	2.0	1.8
28	1.5	1.4	1.4	2.35	3.8	4.35	2.25	2.1	1.8
29	1.6	....	1.4	2.25	3.8	4.15	2.25	2.1	1.8
30	1.65	....	1.45	2.1	3.45	4.15	2.2	2.2	1.7
31	1.75	....	1.45	....	3.2	....	2.1	2.55	....

Note.—Ice conditions from Jan. 1 to 15 and from Jan. 26 to Feb. 14.

Daily discharge, in second-feet, of Frying Pan River at Basalt, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	....	....	65	72	190	660	1,460	204	375
2	....	....	65	80	177	692	1,400	233	355
3	....	....	65	80	190	910	1,400	218	315
4	....	....	65	80	264	1,300	1,460	233	264
5	....	....	65	98	417	1,880	1,880	204	315
6	....	....	65	89	440	2,280	1,350	218	335
7	....	....	65	80	490	2,490	1,040	233	335
8	....	....	65	60	540	2,630	870	218	315
9	....	....	65	65	515	2,560	795	248	280
10	....	....	72	72	570	2,210	725	233	264
11	....	....	89	89	630	2,210	692	233	248
12	....	....	98	80	660	2,080	600	233	248
13	....	....	98	80	570	2,210	570	264	248
14	....	....	89	80	490	2,210	540	233	248
15	....	65	98	98	490	2,210	540	190	248
16	72	65	89	118	630	2,140	490	190	248
17	55	65	72	177	570	2,630	465	248	248
18	55	72	65	218	660	2,930	418	355	248
19	60	72	65	264	760	3 300	395	355	233
20	55	72	80	298	910	3,080	375	280	218
21	55	80	80	233	950	3,000	395	248	190
22	55	89	72	152	1,090	2,420	375	218	190
23	55	98	65	152	1,140	2,420	375	218	190
24	60	80	72	152	950	2,420	375	218	177
25	65	65	72	152	870	2,420	355	218	164
26	....	65	80	204	870	2,020	315	190	164
27	....	72	72	264	995	2,020	315	190	140
28	....	65	65	298	1,240	1,880	264	218	140
29	....	....	65	264	1,240	1,640	264	218	140
30	....	....	72	218	910	1,640	248	248	118
31	....	....	72	....	725	....	218	375	....

NOTE.—These discharges are based on a rating curve, well defined between 50 and 2,800 second-feet. Daily discharge for ice periods Jan. 1 to 15 and Jan. 26 to Feb. 14, estimated as 75 second-feet.

Monthly discharge of Frying Pan River at Basalt, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	....	....	69.8	4,290	C.
February	....	....	74.1	4,120	C.
March	98	65	73.8	4,540	B.
April	298	60	146	8,690	B.
May	1,240	177	682	41,900	A.
June	3,300	660	2,150	128,000	B.
July	1,880	218	676	41,600	A.
August	375	190	238	14,600	A.
September	375	118	240	14,300	A.
The period	....	....	....	262,000	

CRYSTAL RIVER NEAR CARBONDALE, COLO.

This station, which was established July 18, 1908, is located on a single-span highway bridge 150 feet above a section house, at a railroad point known as Sewell, on the Redstone branch of the Denver & Rio Grande Railroad. It is about 5 miles above Carbondale. Station was discontinued September 30, 1909.

No important tributaries enter below the station, but Thompson Creek comes in a short distance above. The drainage area of the river below the mouth of Thompson Creek is about 300 square miles.

Several irrigation ditches, with a combined maximum capacity of probably 100 second-feet, divert water above. The fall, run-off, and storage sites, however, make this essentially a power stream, especially on the upper reaches. Present power plants above the station generate 1,150 horsepower. (See Pl. V, *A*.)

Ice during the winter months prevents the use of open-channel methods of calculating the discharge.

No change has occurred in either location or datum of the staff gage at the bridge during the maintenance of the station.

Except as affected by ice, the results at this station are satisfactory.

Discharge measurements of Crystal River near Carbondale, Colo., in 1909.

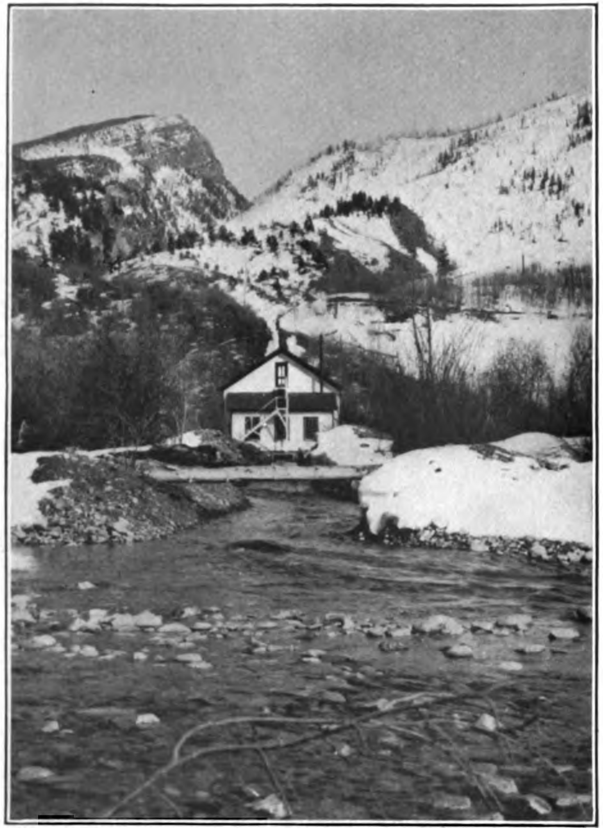
Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec. ft.*
Jan. 15	C. L. Chatfield	52	126	1.85	111
Mar. 18	.....do	52	128	1.80	97
Apr. 22	.....do	54	147	2.50	286
June 22	Chatfield and Snelson, jr	59.5	386	5.48	3,160
July 12	.....do	57	275	3.96	1,170
Aug. 7	.....do	55	210	2.80	445
Oct. 11	Russell and Weaver	48.5	134	2.20	185

Daily gage height, in feet, of Crystal River near Carbondale, Colo., for 1909.

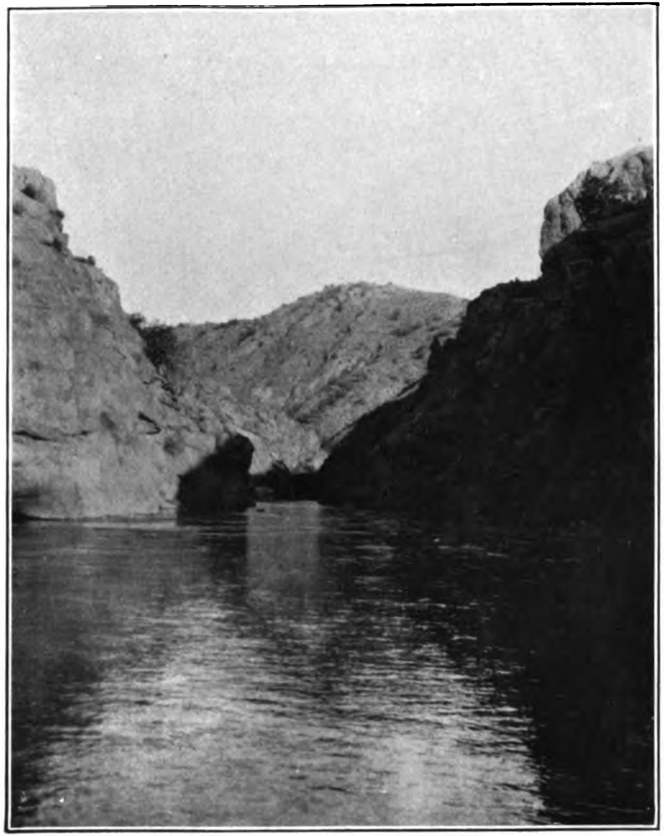
[Alfred Blotham, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.60	2.20	1.75	1.85	2.75	3.80	5.45	3.05	2.65
2	1.55	2.15	1.75	1.90	2.70	3.80	5.45	2.95	2.75
3	1.60	2.00	1.80	2.10	2.75	4.40	5.35	2.85	2.80
4	1.60	2.00	1.80	2.10	2.95	5.50	5.45	2.80	2.95
5	1.65	1.90	1.80	2.05	3.45	5.90	5.45	2.85	3.10
6	1.70	1.90	1.80	2.05	3.70	5.90	5.25	2.70	3.40
7	1.70	1.90	1.75	2.10	3.70	6.40	5.05	2.65	3.60
8	1.60	1.90	1.75	2.00	3.80	5.80	4.90	2.55	3.45
9	1.60	1.90	1.75	2.00	3.85	5.55	4.75	2.65	3.50
10	1.70	1.90	1.75	1.90	4.05	5.45	4.45	2.65	3.55
11	1.70	1.90	1.75	1.90	3.95	5.60	4.20	2.95	3.40
12	1.70	1.90	1.80	1.90	3.85	5.50	4.05	2.90	3.35
13	1.80	1.80	1.80	1.90	3.65	5.40	4.15	3.05	3.25
14	1.90	1.70	1.80	1.95	3.50	5.20	3.95	2.85	2.90
15	1.90	1.65	1.70	2.10	3.45	5.30	3.90	2.65	2.70
16	1.90	1.70	1.75	2.30	3.65	5.45	3.80	2.80	2.45
17	1.75	1.70	1.85	2.75	3.75	5.65	3.65	3.05	2.45
18	1.65	1.65	1.85	2.90	3.90	5.60	3.50	3.05	2.15
19	1.60	1.60	1.85	3.00	4.25	5.95	3.40	3.00	2.05
20	1.60	1.60	1.85	2.85	4.40	6.15	3.35	2.85	2.00
21	1.75	1.60	1.90	2.80	4.55	6.05	3.40	2.65	1.95
22	1.85	1.65	1.90	2.70	4.50	5.90	3.35	2.50	1.90
23	1.80	1.70	1.90	2.60	4.45	5.75	3.45	2.50	1.85
24	1.80	1.65	1.85	2.60	4.50	5.70	3.50	2.50	1.85
25	1.75	1.80	1.85	2.65	4.55	5.90	3.40	2.70	1.80
26	1.75	1.75	1.90	2.75	4.45	5.90	3.30	2.85	1.80
27	1.75	1.80	1.90	2.95	4.60	5.80	3.35	2.80	1.75
28	1.80	1.70	1.85	3.10	4.60	5.60	3.30	2.55	1.70
29	1.80	....	1.85	2.95	4.30	5.35	3.20	2.55	1.65
30	1.80	....	1.85	2.75	4.20	5.25	3.10	2.65	1.60
31	2.20	....	1.85	....	4.05	....	3.00	2.70	....

NOTE.—Open-water conditions probably prevailed during the winter months except the period Jan. 31 to Feb. 4.



A. POWER PLANT OF COLORADO YULE MARBLE CO., ON CRYSTAL RIVER NEAR MARBLE, COLO.



B. MIDDLE BOX CANYON OF GILA RIVER, NEAR REDROCK, N. MEX.

Daily discharge, in second-feet, of Crystal River near Carbondale, Colo., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	73	105	95	112	380	1,040	3,100	531	336
2	67	105	95	121	357	1,040	3,100	477	380
3	73	105	103	164	380	1,610	2,940	427	403
4	73	105	103	164	477	3,190	3,100	403	477
5	80	121	103	152	780	3,950	3,100	427	559
6	87	121	103	152	965	3,950	2,760	357	745
7	87	121	95	164	965	4,970	2,440	336	890
8	73	121	95	141	1,040	3,750	2,230	296	780
9	73	121	95	141	1,080	3,280	2,020	336	815
10	87	121	95	121	1,260	3,100	1,660	336	852
11	87	121	95	121	1,170	3,370	1,400	477	745
12	87	121	103	121	1,080	3,190	1,260	451	712
13	103	103	103	121	928	3,020	1,350	531	648
14	121	87	103	131	815	2,680	1,170	427	451
15	121	80	87	164	780	2,850	1,120	336	357
16	121	87	95	216	928	3,100	1,040	403	262
17	95	87	112	380	1,000	3,460	928	531	262
18	80	80	112	451	1,120	3,370	815	531	176
19	73	73	112	503	1,450	4,050	745	503	152
20	73	73	112	427	1,610	4,450	712	427	141
21	95	73	121	403	1,780	4,250	745	336	131
22	112	80	121	357	1,720	3,950	712	278	121
23	103	87	121	315	1,660	3,660	780	278	112
24	103	80	112	315	1,720	3,560	815	278	112
25	95	103	112	336	1,780	3,950	745	357	103
26	95	95	121	380	1,660	3,950	679	427	103
27	95	103	121	477	1,840	3,750	712	403	95
28	103	87	112	559	1,840	3,370	679	296	87
29	103	....	112	477	1,500	2,940	617	296	80
30	103	....	112	380	1,400	2,760	559	336	73
31	105	....	112	....	1,260	....	503	357	....

NOTE.—These discharges are based on a rating curve that is well defined below a discharge of 1,000 second feet. Discharges estimated Jan. 31 to Feb. 4.

Monthly discharge of Crystal River near Carbondale, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	121	67	91.8	5,640	B.
February	121	73	98.8	5,490	B.
March	121	87	106	6,520	A.
April	559	112	269	16,000	A.
May	1,840	357	1,180	72,600	A.
June	4,970	1,040	3,320	198,000	A.
July	3,100	503	1,440	88,500	A.
August	531	278	393	24,200	A.
September	890	73	372	22,100	A.
The period	....	....	....	439,000	

DIVIDE CREEK BASIN.

DESCRIPTION.

Divide Creek enters Grand River from the south side, about 6 miles below Newcastle, Colo. It is formed by the junction of East and West Divide creeks a few miles above the mouth of the stream. The run-off is derived chiefly from the melting snows in the spring and from rain.

WEST DIVIDE CREEK AT HOSTUTLER'S RANCH, NEAR RAVEN, COLO.

This station, which was established July 27, 1909, is located 5 miles above Raven post office, Colo., one-fourth of a mile below the headgates of the High Line ditch and 2 miles above the head of the Porter ditch.

Gage readings were discontinued for the season on September 20, 1909.

The vertical staff gage is fastened to a large overhanging cottonwood tree on the right bank about 300 feet west of J. K. Hostutler's house.

Discharge measurements are made by wading in the vicinity of the gage.

The following discharge measurement was made by W. B. Freeman and R. E. Vickery:

July 27, 1909; width, 10 feet; area, 89 square feet; gage height, 1.00 feet; discharge, 15.1 second-feet.

Daily gage height, in feet, of West Divide Creek at Hostutler's ranch near Raven, Colo., for 1909.

[J. K. Hostutler, observer.]

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1		0.65	0.85	11		0.8	0.85	21		0.85	
2		.7	.75	12		.85	1.1	22		.85	
3		.7	.7	13		.7	1.1	23		.9	
4		.6	.8	14		.6	1.05	24		1.05	
5		.6	.85	15		.55	.95	25		.8	
6		.6	1.1	16		.6	.9	26		.7	
7		.85	1.2	17		.85	.8	27	1.0	.7	
8		.7	1.15	18		1.0	.75	28	.95	.6	
9		.6	1.0	19		1.1	.7	29	.85	.6	
10		.7	.9	20		.95	.7	30	.8	.65	
								31	.7	.8	

WEST DIVIDE CREEK AT RAVEN, COLO.

This station, which was established July 27, 1909, is located at Raven post office, Colo., 14 miles south of Newcastle.

The vertical staff gage is about 150 feet downstream from a highway bridge, at which high-water discharge measurements will be taken. Numerous ditches, of which the High Line and the Porter are the most important, divert water above this station.

Fair results should be obtained at this station. Ice affects the gage heights for a few months during the winter season.

The following discharge measurement was made by W. B. Freeman:

July 27, 1909; width, 4.6 feet; area, 3.7 square feet; gage height, 1.18 feet; discharge, 4.2 second-feet. Made by wading below gage.

Daily gage height, in feet, of West Divide Creek at Raven, Colo., for 1909.

[John F. Collins, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	1.1	1.3	......	1.2	1.2	16	......	1.1	1.4	1.2	1.2	1.2
2	......	1.1	1.3	......	1.2	1.2	17	......	1.2	1.4	1.2	1.2	1.2
3	......	1.1	1.3	1.2	1.2	1.2	18	......	1.25	1.3	1.2	1.2	1.2
4	......	1.1	1.3	1.2	1.2	1.2	19	......	2	1.3	1.2	1.2	1.2
5	......	1.1	1.3	1.2	1.2	1.2	20	......	1.5	1.3	1.2	1.2	1.2
6	......	1.1	1.3	1.2	1.2	1.2	21	......	1.5	1.3	1.2	1.2	1.2
7	......	1.1	1.65	1.2	1.2	1.2	22	......	1.2	1.3	1.2	1.2	1.2
8	......	1	1.5	1.2	1.2	1.2	23	......	1.25	1.3	1.2	1.2	1.2
9	......	1	1.5	1.2	1.2	1.2	24	......	1.35	1.2	1.2	1.2	1.2
10	......	1.1	1.4	1.2	1.2	1.2	25	......	1.35	1.2	1.2	1.2	1.2
11	......	1.2	1.4	1.2	1.2	1.2	26	......	1.15	1.2	1.2	1.2	1.2
12	......	1.2	1.65	1.2	1.2	1.2	27	1.15	1.2	1.2	1.2	1.2	1.2
13	......	1.1	1.55	1.2	1.2	1.2	28	1.1	1.1	1.2	1.2	1.2	1.2
14	......	1	1.55	1.2	1.2	1.2	29	1.0	1.2	1.2	1.2	1.2	1.2
15	......	1.05	1.5	1.2	1.2	1.2	30	1.2	1.2	1.2	1.2	1.2	1.2
							31	1.2	1.2	......	1.2	......	1.2

Daily discharge, in second-feet, of West Divide Creek at Raven, Colo., for 1909.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	2.5	8.5	5.0	5.0	5.0	16	......	2.5	13	5.0	5.0	5.0
2	......	2.5	8.5	5.0	5.0	5.0	17	......	5.0	13	5.0	5.0	5.0
3	......	2.5	8.5	5.0	5.0	5.0	18	......	6.8	8.5	5.0	5.0	5.0
4	......	2.5	8.5	5.0	5.0	5.0	19	......	61	8.5	5.0	5.0	5.0
5	......	2.5	8.5	5.0	5.0	5.0	20	......	18	8.5	5.0	5.0	5.0
6	......	2.5	8.5	5.0	5.0	5.0	21	......	18	8.5	5.0	5.0	5.0
7	......	2.5	28	5.0	5.0	5.0	22	......	5.0	8.5	5.0	5.0	5.0
8	......	1.0	18	5.0	5.0	5.0	23	......	6.8	8.5	5.0	5.0	5.0
9	......	1.0	18	5.0	5.0	5.0	24	......	10.8	5.0	5.0	5.0	5.0
10	......	2.5	13	5.0	5.0	5.0	25	......	10.8	5.0	5.0	5.0	5.0
11	......	5.0	13	5.0	5.0	5.0	26	......	3.8	5.0	5.0	5.0	5.0
12	......	5.0	28	5.0	5.0	5.0	27	3.8	5.0	5.0	5.0	5.0	5.0
13	......	2.5	22	5.0	5.0	5.0	28	2.5	2.5	5.0	5.0	5.0	5.0
14	......	1.0	22	5.0	5.0	5.0	29	1.0	5.0	5.0	5.0	5.0	5.0
15	......	1.8	18	5.0	5.0	5.0	30	5.0	5.0	5.0	5.0	5.0	5.0
							31	5.0	5.0	......	5.0	......	5.0

NOTE.—These discharges are based on a curve that is well defined by measurements made in 1910.

Monthly discharge of West Divide Creek at Raven, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
July 27-31	5.0	1.0	3.46	34	B.
August	61	1.0	6.71	412	B.
September	28	5.0	11.4	678	B.
October	5.0	5.0	5.0	307	B.
November	5.0	5.0	5.0	298	B.
December	5.0	5.0	5.0	307	B.
The period	......	......	......	2,040	

MAMM CREEK BASIN.

WEST MAMM CREEK NEAR RIFLE, COLO.

Mamm Creek, which enters Grand River from the south about 4 miles upstream from Rifle, Colo., is formed by the junction of West Mamm, East Mamm, and Middle Mamm, all of which rise on the north side of Battlement Mesa.

The flow of this stream is supplied by melting snow in the spring and by rains. Its channel is usually dry or nearly so during the late summer and fall.

The gaging station, which was established July 26, 1909, is located just south of J. T. Selby's ranch house, 9 miles south of Rifle, Colo., about half a mile above the mouth of Quakenasp Gulch Creek, and three-fourths of a mile above the dam site of a proposed irrigation reservoir, which has a capacity of a few thousand acre-feet. One ditch, of less than 10 second-feet capacity, diverts water above the station. The waste water from this ditch is returned to the creek a few feet above the staff gage.

Beginning November 16, 1909, a 24-inch trapezoidal sharp-edge weir, with end contractions, was used to measure the flow of the stream. This weir is located about 50 feet downstream from the gage. Current-meter measurements are made at various sections in the vicinity of gage.

Ice exists to some extent for quite an extended period during the winter season. Conditions at this station are not conducive to the most accurate results, especially during the higher stages, when gage heights show great fluctuations and measurements are difficult to make.

Daily gage height, in feet, of West Mamm Creek near Rifle, Colo., for 1909.

[J. T. Selby, observer.]

Day.	July.	Aug.	Nov.	Dec.	Day.	July.	Aug.	Nov.	Dec.	Day.	July.	Aug.	Nov.	Dec.
1	......	0.5	......	0.21	11	......	1.2	......	0.21	21	......	1.15	0.50	0.21
2	......	1.0	......	.21	12	......	1.75	......	.21	22	......	.6	.75	.21
3	......	.95	......	.21	13	......	.9	......	.21	23	......	.5	.83	.21
4	......	.65	......	.21	14	......	.65	......	.21	24	......	.5	.67	.21
5	......	.5	......	.21	15	......	.5	......	.21	25	......	.5	.67	.21
6	......	.5	......	.21	16	......	1.2	0.21	.21	26	1.0	.5	.58	.21
7	......	.5	......	.21	17	......	2.0	.21	.21	27	.8	5	.50	.21
8	......	.5	......	.21	18	......	.55	.21	.21	28	.5	.5	.33	.21
9	......	.5	......	.21	19	......	.8	.25	.21	29	.5	......	.25	.38
10	......	.5	......	.21	20	......	.8	.25	.21	30	.5	......	.25	.42
										31	.5	......	......	.42

NOTE.—Gage heights July 26 to Aug. 28 are from staff gage. Readings Nov. 16 to Dec. 31 are heads on the weir. Observer recorded in inches, and his readings have been converted into decimals of a foot.

Daily discharge, in second-feet, of West Mamm Creek near Rifle, Colo., for 1909.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		0.6	11		0.6	21	2.4	0.6
2		.6	12		.6	22	4.3	.6
3		.6	13		.6	23	5.0	.6
4		.6	14		.6	24	3.6	.6
5		.6	15		.6	25	3.6	.6
6		.6	16	0.6	.6	26	2.9	.6
7		.6	17	.6	.6	27	2.4	.6
8		.6	18	.6	.6	28	1.3	.6
9		.6	19	.8	.6	29	.8	.8
10		.6	20	.8	.6	30	.8	1.8
						31		1.8

NOTE.—These discharges were obtained from the weir formula $Q=3.33LH^{\frac{3}{2}}$. See Water-Supply Paper 200, p. 162.

Monthly discharge of West Mamm Creek near Rifle, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
Nov. 16-30	2.9	0.6	2.03	60
December	1.8	.6	.68	42

NOTE.—These estimates are approximate.

GUNNISON RIVER BASIN.

DESCRIPTION.

Gunnison River is formed in Gunnison County, Colo., by the union of East and Taylor rivers, two streams that originate among the snow-covered peaks and on the slopes of the Continental Divide in the northeastern part of the county, descend through narrow mountain valleys, and unite about 12 miles above Gunnison. From the junction of these rivers the Gunnison flows west and southwest to the point where it enters Grand River at Grand Junction, in the central part of Mesa County, Colo.

The upper course of the river lies through a broad, mountainous valley, but near the mouth of Lake Fork the valley narrows and the river enters Black Canyon of the Gunnison, through which it winds in a tortuous course for 56 miles between granite walls that rise precipitously 3,000 feet above the water's edge. A short distance below the mouth of North Fork, the largest tributary of the river, the canyon walls break abruptly, and the valley is broad and fertile. Below Delta the river enters another narrow canyon, with walls averaging 800 feet in height, and this continues irregularly to Grand Junction, only a few tracts of narrow bottom land lying between the channel and the canyon walls.

The soil of the lower valleys is chiefly adobe, and the higher mesas contain much gravel and sand. Groves of quaking aspen interspersed with large, open grazing plots cover broad areas of this plateau region. On the top of the Grand Mesa are forests of pine and aspen, and piñon and cedar grow along the foothills. In the valleys chico and sagebrush form the principal vegetation, except along the streams, which are bordered in places by cottonwood, willow, and undergrowth.

The chief tributaries of the Gunnison are Ohio, Tomichi, Lake Fork, and Cimarron creeks, and Smith, North Fork, and Uncompahgre rivers, North Fork being the largest.

North Fork rises in the Huntsman Hills, 20 miles south of Glenwood Springs, flows in a general southerly and southwesterly course, and unites with the Gunnison about 8 miles west of Hotchkiss. The drainage area is mountainous, except for a small portion which lies below Paonia, extreme points reaching an altitude of 13,000 feet. The mesa lands at the lower end of the valley stand 5,500 feet above sea level. The higher peaks are formed of granite rocks, but lower down, sedimentary formations occupy at least 80 per cent of the area of the basin. The mountains are forested and the mesa lands are covered with sagebrush. All the tillable lands of the North Fork and its tributaries have been brought under cultivation, and irrigation is practiced to such an extent that the entire flow is needed for existing systems.

Uncompahgre River, the principal tributary of the Gunnison from the south, rises among the snowy peaks of the highly serrated Uncompahgre Mountains and flows a little west of north to its junction with the Gunnison at Delta. The basin embraces a mountainous plateau and valley area of 1,130 square miles, oblong in shape, the width increasing slightly at the lower end. The mountain area occupies but a small part of the basin, but contributes the perennial waters of the stream. The plateau area is greatest in extent and borders the valley on both sides, the larger Uncompahgre Plateau lying to the southwest. Escarpments are conspicuous features of this plateau. The relief features are terraced mesas flanked by buttes and ridges and trenched by deep, narrow canyons. Uncompahgre Valley proper begins at a point near Eldredge siding, on the Denver & Rio Grande Railroad.

The other tributaries of the Gunnison need not here be described. Ohio, Tomichi, Lake Fork, and Cimarron creeks are perennial streams, but almost their entire volume is diverted for irrigation during the growing season, so that very little water reaches the Gunnison except at times of heavy storms or during spring floods.

Precipitation records for the Gunnison are meager. Those which exist show a range from 9 inches in the plateau region to about 25 inches in the mountains.

The run-off of the Gunnison drainage basin is conserved to a large extent by four forest reserves, which have a total area of about 5,700 square miles, of which approximately 3,800 square miles are located within the basin. About 65 per cent of this area is in standing timber, the remainder being classified as sagebrush, barren, and burned. Investigation of the headwaters of East River and other tributaries in Gunnison County several years ago discovered that many of the hills had been almost entirely denuded of their timber, a discovery to which may be attributed the setting aside of the areas as forest reserves.

Along Gunnison River proper above the mouth of Lake Fork a number of ditches divert water for meadow irrigation, and irrigation is extensively practiced in the vicinity of Delta. The largest irrigated area in the Gunnison drainage basin is the Uncompahgre Valley. In addition to the lands being irrigated by large private ditches, this valley contains about 150,000 acres, which are being reclaimed under the Uncompahgre project of the United States Reclamation Service. The greater part of the water for this land is diverted from Gunnison River by means of the Gunnison tunnel, which has a capacity of 1,300 second-feet. The formal opening of Gunnison tunnel was celebrated at the west portal of the tunnel September 23, 1909, with the President of the United States, the Secretary of the Interior, and officials of the Reclamation Service in attendance. The construction of the tunnel was begun in January, 1905, and the actual opening through the tunnel was completed July 6, 1909. The present water rights consume the normal flow of Uncompahgre River, and the Uncompahgre Valley project will divert all the available water from Gunnison River during normal stages.

The country is not adapted for large reservoirs, the meadows having so much fall and the valleys being so narrow that construction would be expensive in proportion to reservoir capacity. However, a large number of small reservoirs exist on the Gunnison and its tributaries, which can be advantageously utilized for power.

Power plants at present in operation in this basin develop about 2,200 horsepower, and there are many sites unutilized. The fall along some of the streams is heavy, ranging from 50 to 150 feet to the mile. Along the Uncompahgre, from its source to the 8,000-foot contour, the fall is almost 300 feet to the mile. At the present time the waters in this basin are being used for domestic purposes, irrigation, and power. By utilizing all the available storage it would theoretically be possible to develop about 200,000 horsepower. Along the South canal of the United States Reclamation Service, which receives the water from the Gunnison tunnel and carries it into Uncompaghre River, a series of drops will make possible the development of from 5,000 to 10,000 horsepower.

But two gaging stations were maintained previous to 1900, but since that year a number have been established and discontinued.

The records, as a rule, cover about three-year periods, and show that 1904 was the driest and 1907 the wettest year. By comparison with other drainage basins adjacent to the Gunnison, however, it is evident that 1902 was a drier year than 1904.

GUNNISON RIVER AT RIVER PORTAL, COLO.[1]

This station, which was established April 7, 1905, replaced the station located at Cimarron, about 12 miles above. It is about 300 feet above the portal of the Gunnison tunnel and is about 21 miles northeast of Montrose.

The station is about 8 miles below the mouth of Crystal Creek, and is above North Fork and Uncompahgre River, the two most important tributaries.

A number of small ditches divert water for meadow irrigation above the station. The largest diversion along the river, and also in Colorado, is the recently completed Gunnison tunnel, with a capacity of about 1,300 second-feet, which diverts the water from the Gunnison into the Uncompahgre Valley, where it will be used for irrigation.[2]

Ice covers the river for about four months each year and attains a thickness of 1 to 2 feet. No winter records of discharge have been obtained.

The original staff gage, which was bolted to the cliff on the right bank of the river, was dislodged by driftwood on June 4, 1909. Prior to this date no change occurred in the location or datum of this gage.

From June 5 to 19 an old high-water gage, about 100 feet upstream on the left bank, was read. The datum of this gage is 10.08 feet lower than that of the original gage. The readings were reduced to the original datum. This auxiliary gage could not be used after June 19, as the water surface had fallen too low. On August 9, 1909, a new staff gage was installed at the same location and datum as the original gage. This gage was broken off by ice November 20, 1909.

Discharge measurements were made from a cable located a few feet downstream from the original gage site.

The accuracy of the estimates of daily and monthly discharge is impaired by lack of sufficient discharge measurements to cover slight shifting of channel, and changes resulting from the dumping of débris from the Gunnison tunnel into the river below the station.

This station is maintained under the supervision of the United States Reclamation Service. Computations of discharge have been made by engineers of the United States Geological Survey.

---

[1] This station was referred to in previous reports as at east portal of Gunnison tunnel.

[2] The Gunnison tunnel and Uncompahgre project are described in the reports of the United States Reclamation Service.

Discharge measurements of Gunnison River at River Portal, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 8	A. L. B. Moser	210	2,750	15.78	13,000
9	.....do	210	2,700	15.48	12,900
10	.....do	208	2,570	14.98	11,900
11	.....do	206	2,510	14.68	11,600
12	.....do	205	2,460	14.48	11,400

NOTE.—The gage readings for above measurements are reduced approximately to original gage datum. The measurements were made by the subsurface method, the reduction coefficient used being 0.92.

Daily gage height, in feet, of Gunnison River at River Portal, Colo., for 1909.

[John Dill and W. T. Blight, observers.]

Day.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.	Day.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.
1	6.3	7.8	11	......	7.9	7	5.8	16	7.5	11.3	13.7	7.35	8.3	6.7	5.4
2	6.45	7.8	10.3	......	7.6	7	5.8	17	8	11.2	14.2	7.2	8.2	6.6	5
3	6.8	7.9	11.7	......	7.6	7	5.9	18	8.8	12	14.5	7.45	8.2	6.6	5.15
4	6.9	8.5	13.3	......	7.7	6.9	5.95	19	9.15	12.2	14.7	7.55	8	6.5	5.2
5	6.9	9.9	14.8	......	7.9	6.9	5.9	20	9	12.3	......	7.6	7.8	6.5	......
6	6.4	10.3	15.1	......	10.15	6.95	5.8	21	8.1	12	......	7.6	7.7	6.5	......
7	6.35	11	15.4	......	9.7	7.15	5.7	22	7.85	12.7	......	7.4	7.6	6.4	......
8	6	11.8	15.7	......	9.35	7.1	5.6	23	7.6	12.6	......	7.2	7.5	6.3	......
9	6.2	10.9	15.5	7.2	8.95	7	5.5	24	7.4	12.1	......	7.4	7.4	6.2	......
10	6.2	11.4	15	7.1	8.5	6.9	5.7	25	7.5	11.6	......	7.45	7.3	6.15	......
11	6.1	11.8	14.6	7.3	8.4	7	5.9	26	7.9	12	......	7.2	7.2	6.1	......
12	6.2	11.6	14.3	7.35	8.2	6.9	5.7	27	8.5	12.7	......	7.2	7.1	6	......
13	6.3	11.1	14.5	7.4	8.5	6.9	5.75	28	8.9	13	......	7.1	7.1	6	......
14	6.4	10.8	14	7.4	8.45	6.9	5.7	29	8.7	12.7	......	7	7	6	......
15	6.85	10.7	13.9	7.4	8.4	6.7	5.7	30	8.2	12	......	7.45	7	5.9	......
								31	......	11.5	......	7.7	......	5.85	......

Daily discharge, in second-feet, of Gunnison River at River Portal, Colo., for 1909.

Day.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.
1	1,050	2,300	6,660	....	2,410	1,560	760
2	1,150	2,300	5,500	....	2,100	1,560	760
3	1,400	2,410	7,880	....	2,100	1,560	810
4	1,480	3,070	10,700	....	2,200	1,480	838
5	1,480	4,890	10,800	....	2,410	1,480	810
6	1,120	5,500	12,200	....	5,270	1,520	760
7	1,080	6,660	12,500	....	4,600	1,690	710
8	865	8,060	13,000	....	4,120	1,650	665
9	985	6,490	12,700	1,740	3,600	1,560	620
10	985	7,360	12,100	1,650	3,070	1,480	710
11	925	8,060	11,500	1,820	2,960	1,560	810
12	985	7,710	11,100	1,870	2,730	1,480	710
13	1,050	6,840	11,400	1,920	3,070	1,480	735
14	1,120	6,320	10,700	1,920	3,010	1,480	710
15	1,440	6,150	10,500	1,920	2,960	1,330	710
16	2,010	7,180	10,200	1,870	2,840	1,330	580
17	2,520	7,010	11,000	1,740	2,730	1,260	440
18	3,480	8,410	11,400	1,960	2,730	1,260	488
19	3,790	8,760	11,600	2,060	2,520	1,180	505
20	3,660	8,940	....	2,100	2,300	1,180	....
21	2,620	8,410	....	2,100	2,200	1,180	....
22	2,360	9,640	....	1,920	2,100	1,120	....
23	2,100	9,460	....	1,740	2,010	1,050	....
24	1,920	8,580	....	1,920	1,920	985	....
25	2,010	7,710	....	1,960	1,820	955	....
26	2,410	8,410	....	1,740	1,740	925	....
27	3,070	9,640	....	1,740	1,650	865	....
28	3,540	10,200	....	1,650	1,650	865	....
29	3,300	9,640	....	1,560	1,560	865	....
30	2,730	8,410	....	1,960	1,560	810	....
31	....	7,540	....	2,200	....	785	....

NOTE.—These discharges were obtained from rating curves applicable as follows: Apr. 1 to June 4, and Aug. 9 to Nov. 19, well defined below 8,000 second-feet; June 5 to June 19, well defined.

Monthly discharge of Gunnison River at River Portal, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April	3,790	865	1,950	116,000	B.
May	10,200	2,300	7,160	440,000	B.
June 1-19	13,000	5,500	10,800	407,000	B.
Aug. 9-31	2,200	1,560	1,870	85,300	B.
September	5,270	1,560	2,600	155,000	B.
October	1,690	785	1,270	78,100	B.
Nov. 1-19	838	440	691	26,000	C.
The period				1,310,000	

UNCOMPAHGRE RIVER AT FORT CRAWFORD, COLO.

This station, which was established October 2, 1907, to obtain information concerning the water supply above the principal diversions in the Uncompahgre Valley, replaces the station near Colona which was established August 10, 1903. Its present location is at a highway bridge across Uncompahgre River about half a mile west of Fort Crawford, in sec. 36, T. 48 N., R. 9 W.

The station is located just below the mouth of Horsefly Creek. A number of large private irrigation ditches divert water above this station. Existing power plants generate about 1,800 horsepower. Opportunity for extensive power development is found on the headwaters.

Thick ice forms along the edges of the river during the winter months. The channel remains open at the station, but slush ice affects the accuracy of the results at times. The channel scours during high stages and silts during periods of low water.

On June 21, 1908, the rod gage, which was established October 2, 1907, was washed out. On July 7, 1908, a temporary chain gage was installed. The zero of this gage was placed 1.95 feet below the zero of the rod gage. On July 23, 1908, a permanent rod gage was installed, the zero of which corresponds to 0.70 foot on the first rod gage, and to 2.65 feet on the chain gage.

During 1909 the chain gage, established July 7, 1908, was used. In the early part of 1910 a new rod gage was established with a datum 3.20 feet lower than that of the chain gage. The readings for 1909 have been reduced to this datum.

This station was maintained under the supervision of the United States Reclamation Service.

Discharge measurements of Uncompahgre River at Fort Crawford, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 16	R. M. Adams	56.5	70	1.60	251
July 19	do	54	97	2.00	361
27	do	58	118	2.60	502
Aug. 19	do	61	98	2.45	457
Oct. 6	do	57.5	71	1.30	266

Daily gage height, in feet, of Uncompahgre River at Fort Crawford, Colo., for 1909.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1		2.1	1.2	11	1.9	1.85	1.2	21	2.25	1.7	
2		2.25	1.2	12	2.0	2.1		22	2.2	1.6	
3		2.4	1.2	13	2.05	2.15		23		1.6	
4		2.05	1.2	14	1.95	2.0		24	2.3	1.5	
5		2.9	1.4	15	2.3	1.95		25	2.25	1.5	
6	2.0	2.6	1.35	16	2.3	2.0		26	2.25	1.4	
7	2.15	2.5	1.25	17	2.2	2.05		27	2.25	1.4	0.9
8	2.15	2.4	1.25	18	2.3	1.9		28	2.15	1.45	1.0
9	2.15	2.15	1.25	19	2.4	1.9		29	2.2	1.35	
10	2.0	2.0	1.2	20	2.35	1.8		30	2.3	1.25	
								31	2.25		

Daily discharge, in second-feet, of Uncompahgre River at Fort Crawford, Colo., for 1909.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1	240	380	230	11	210	315	230	21	345	340	140
2	240	480	230	12	245	435	230	22	320	300	140
3	240	535	230	13	260	515	230	23	345	300	140
4	240	355	230	14	230	435	230	24	365	260	140
5	240	885	305	15	365	410	230	25	345	305	140
6	245	660	285	16	365	435	230	26	400	265	140
7	300	670	250	17	320	460	230	27	400	265	140
8	300	605	250	18	365	385	230	28	350	285	165
9	300	460	250	19	410	440	140	29	375	250	150
10	245	380	230	20	390	390	140	30	420	210	150
								31	400		150

NOTE.—These discharges were obtained by the indirect method for shifting channels. Discharges estimated for days when gage was not read.

Monthly discharge of Uncompahgre River at Fort Crawford, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
August		210	317	19,500	C.
September	885	210	414	24,600	C.
October			200	12,300	D.

UNCOMPAHGRE RIVER AT MONTROSE, COLO.

This station, which was reestablished April 22, 1903, to obtain for the United States Reclamation Service definite information concerning the amount of water carried by the Uncompahgre, is located at the iron highway bridge just west of Montrose and one-fourth mile west of the Denver & Rio Grande Railroad.

The station is about 2 miles above Happy Canyon Creek and is also above Cedar and Spring creeks. Large irrigation ditches divert water between this station and that at Fort Crawford. Existing water rights control the normal flow of this river for irrigation. Above these diversions, however, opportunities exist for storage and power development. Established plants generate about 1,800 horsepower. Open-channel conditions obtain at this station, although thick ice usually forms along the edges. Slush and anchor ice sometimes influence the accuracy of the results. The flow is controlled during the irrigation season by the large diversions above. The flow at this point will also be affected by the inflow from the south canal of the United States Reclamation Service when that canal is completed.

Neither the location nor the datum of the staff gage, which is 20 feet upstream from the bridge, has been changed during the maintenance of the station.

Results obtained are good except during winter periods and extreme low water.

This station is maintained under the supervision of the United States Reclamation Service.

Discharge measurements of Uncompahgre River at Montrose, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 7	R. M. Adams	84	206	5.10	1,070
July 19	do	28	58	2.70	160
27	do	31.5	72	3.10	224
Aug. 5	do	28	53	2.50	86
12	do	28	59	2.70	124
20	do	33	83	3.50	320
Oct. 7	do	28	54	2.65	110

Daily gage height, in feet, of Uncompahgre River at Montrose, Colo., for 1909.

[Thomas Reeves, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.3	2.15	2.1	4.75	2.8	3.5	2.45	2.5
2	2.3	2.25	2.2	4.55	3.0	3.05	2.4	2.6
3	2.5	2.1	2.5	4.7	2.6	3.1	2.4	2.5
4	2.5	2.6	3.6	4.55	2.55	3.75	2.4	2.55
5	2.55	3.5	4.8	4.5	2.7	4.05	2.3	2.5
6	2.5	3.55	5.35	4.5	2.5	4.7	2.3	2.35
7	2.5	3.6	5.8	4.0	2.5	4.8	2.7	2.25
8	2.3	3.6	5.05	3.7	2.5	4.45	2.6	2.2
9	2.35	3.2	4.9	3.7	2.45	4.3	2.55	2.1
10	2.5	3.1	4.8	3.6	2.6	4.15	2.6	2.1
11	2.5	3.5	5.0	3.45	2.7	4.2	2.55	2.05
12	2.4	3.3	5.1	2.95	2.65	3.9	2.5	2.05
13	2.45	3.4	5.35	2.65	3.0	4.65	2.45	1.95
14	2.5	2.75	4.8	2.45	2.7	4.3	2.4	2.0
15	2.65	2.45	4.95	2.3	3.1	4.1	2.45	2.05
16	3.05	2.5	5.35	2.45	3.05	4.2	2.5	2.0
17	4.05	2.5	5.4	2.7	2.8	4.2	2.5	2.05
18	4.15	2.4	5.45	2.5	3.55	4.1	2.5	2.05
19	3.90	2.7	5.5	2.55	3.2	3.9	2.4	2.1
20	3.55	3.1	5.45	2.5	3.4	3.65	2.45	2.1
21	3.15	2.7	5.5	2.35	2.95	3.6	2.4	2.05
22	2.7	2.45	5.6	2.55	3.4	3.4	2.5	2.15
23	2.8	2.55	5.65	3.2	3.2	3.35	2.3	2.1
24	2.85	2.45	5.6	3.75	3.5	3.2	2.2	2.1
25	2.8	2.55	5.8	3.3	3.2	3.2	2.1	2.05
26	2.7	2.5	5.3	3.1	3.25	3.0	2.0	2.05
27	2.6	2.55	5.1	3.05	3.05	2.9	2.0	2.0
28	3.15	2.6	4.9	2.8	2.8	2.75	2.0	2.05
29	2.85	2.65	5.0	2.7	2.95	2.65	2.0	2.1
30	2.5	2.5	5.0	2.9	3.1	2.55	2.0	2.1
31	....	2.15	....	2.8	3.6	....	2.0	....

Daily discharge, in second-feet, of Uncompahgre River at Montrose, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	75	52	45	880	139	333	75	83
2	75	68	60	777	183	196	67	100
3	107	45	107	854	100	200	67	83
4	107	127	402	777	92	425	67	92
5	117	370	912	752	119	545	53	83
6	107	386	1,200	752	83	854	53	60
7	107	402	1,450	524	83	906	119	47
8	75	402	1,040	406	83	728	100	41
9	82	277	964	406	75	656	92	30
10	107	249	912	369	100	588	100	30
11	107	370	1,020	316	119	610	92	25
12	90	306	1,070	172	110	484	83	25
13	98	338	1,200	110	183	828	75	16
14	107	159	912	75	119	656	67	21
15	138	98	990	53	209	566	75	25
16	236	107	1,200	75	196	610	83	21
17	568	107	1,230	119	139	610	83	25
18	610	90	1,250	83	351	566	83	25
19	510	148	1,280	92	237	484	67	30
20	386	249	1,250	83	299	388	75	30
21	263	148	1,280	60	172	369	67	25
22	148	98	1,340	92	299	299	83	36
23	170	117	1,360	237	237	283	53	30
24	183	98	1,340	425	333	237	41	30
25	170	117	1,450	267	237	237	30	25
26	148	107	1,170	209	252	183	21	25
27	127	117	1,060	196	196	160	21	21
28	263	127	958	139	139	129	21	25
29	183	138	1,010	119	172	110	21	30
30	107	107	1,010	160	209	92	21	30
31	....	52	....	139	360	....	21	....

NOTE.—These discharges are based on rating curves applicable as follows: April 1 to June 25, well defined between 30 and 600 second-feet; June 26 to Nov. 30, not well defined.

Monthly discharge of Uncompahgre River at Montrose, Colo., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
April	610	75	186	11,100	B.
May	402	45	180	11,100	B.
June	1,450	45	1,020	60,700	A.
July	880	53	313	19,200	A.
August	369	75	182	11,200	A.
September	906	92	445	26,500	A.
October	119	21	63.7	3,920	B.
November	100	16	38.9	2,310	B.
The period				146,000	

UNCOMPAHGRE RIVER NEAR DELTA, COLO.

This station was originally established April 29, 1903, at a highway bridge one-fourth mile above the Denver & Rio Grande Railroad bridge. On November 17, 1903, it was removed to the railroad bridge, one-fourth mile northwest of the depot at Delta, Colo. The vertical gage at this bridge was read until April 21, 1904, when an inclined gage was installed on the right bank near the bridge. This gage was read until November, 1906, when a staff gage was installed at the present location, on the second highway bridge 2 miles south of Delta. Observations were not begun at this gage until April 21, 1907. It was washed out September 6, 1909, and not repaired.

The station is located near the junction of the Uncompahgre with the Gunnison and is below all tributaries and diversions. At ordinary stages the flow of the river at this point is nearly all seepage water from the irrigation of ditches above. During the irrigation season the ditches consume all the normal flow.

Results are probably not materially affected by ice, as ice does not form very thick except along the edges of the stream. Slush ice frequently occurs.

There is no determined relation between the datum of the last established gage and the several earlier gages, and the datum of the gage used from April 22, 1904, to November, 1906, is different from that of the previous gage.

Records obtained at this station are good except during extremely low stages.

This station is maintained under the supervision of the United States Reclamation Service.

The daily and monthly estimates for this station are withheld until more high-water measurements have been obtained.

Discharge measurements of Uncompahgre River near Delta, Colo., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 28	R. M. Adams	42	101	2.54	242
June 5	.....do	48	98	2.45	294
July 20	.....do	40	42.4	1.57	21.1
29	.....do	48	61.4	1.70	43.3
Aug. 20	.....do	48	108	2.80	356
Oct. 22	.....do	50	69	....	109

Daily gage height, in feet, of Uncompahgre River near Delta, Colo., for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.8	1.9	1.95	3.65	1.7	2.5	16	2.05	2.05	3 85	1.7	2.15	......
2	1.8	1.75	1.9	3.45	1.7	2.5	17	2.4	2.0	3.85	1.7	2.3	......
3	1.8	1.95	1.9	3.35	1.65	3.1	18	3.2	2.15	4.3	1.7	2.65	......
4	1.8	2.4	2.0	3.4	1.6	3.5	19	3.4	2.55	4.6	1.7	3.0	......
5	1.9	2.75	3.0	3.85	1.6	3.65	20	3.3	2.55	4.4	1.75	2.65	......
6	2.0	3.4	3.5	3.8	1.6	4.5	21	3.1	2.55	4.35	1.6	2.6	......
7	2.1	3.45	3.95	3.55	1.7	......	22	2.55	2.25	4.1	2.25	2.55	......
8	1.95	3.65	4.15	3.15	1.7	......	23	2.2	2.45	4.2	2.05	2.35	......
9	1.9	3.4	4.25	2.75	1.65	......	24	1.9	2.3	4.25	2.3	2.45	......
10	1.9	3.25	4.1	2.5	2.3	......	25	1.75	2.2	4.1	2.0	2.5	......
11	1.9	3.25	3.95	2.45	2.5	......	26	1.85	2.1	4.05	2.0	2.45	......
12	1.9	3.25	3.9	2.0	2.0	......	27	2.25	2.3	3.95	1.95	2.6	......
13	1.9	3.05	3.9	2.0	1.85	......	28	2.6	2.5	3.85	1.8	2.25	......
14	1.8	2.65	3.8	2.0	2.35	......	29	2.5	2.45	3.6	1.7	2.0	......
15	1.8	2.25	3.75	1.8	2.15	......	30	2.1	2.3	3.65	1.7	2.0	......
							31	......	2.15	......	1.65	2.2	......

NOTE.—Gage washed out on Sept. 6.

FREMONT RIVER BASIN.

DESCRIPTION.

Fremont River heads in the eastern slopes of the Wasatch Mountains in Sevier County, Utah, one of its sources being Fish Lake. It flows in a general southerly direction to Thurber, from which point it traverses the central portion of Wayne County in a general easterly direction to Hawksville, where it turns southward; it joins Colorado River about 8 miles above Hite, Utah. It receives one important tributary, Curtis Creek,[1] from the north and a number of smaller streams, including Tantalus and Lewis creeks, from the south. The lower half of its course is through two deep canyons separated by a valley. On the upper water of the main river is what is known as Rabbit Valley. Both Fremont River and Curtis Creek are considerably augmented in volume by springs in their canyons, but they derive the greater part of their waters from melting snows on the plateau.

FREMONT RIVER NEAR THURBER, UTAH.

This station, which was established May 13, 1909, is located about 2 miles (by road) south of Thurber, Utah. The records show the total amount of water available for storage in a reservoir proposed at this point.

---

[1] Called Muddy River on General Land Office maps.

Pine Creek enters about 2 miles above the station. This creek and springs in the valley just above the station furnish much of the low-water flow. Most of the normal low-water flow is diverted above and below the station for irrigation.

The staff gage is on the left bank about 2,000 feet above a gristmill. The gage height records are probably not much affected by ice. Discharge measurements are made from a cable at the gage.

As the bed of the stream is of a shifting character, frequent measurements are necessary for reliable estimates of daily and monthly discharge.

Discharge measurements of Fremont River near Thurber, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 13	E. A. Porter	29	61	4.25	116
June 30	.....do	28	64.4	4.35	67.3
Aug. 11	.....do	28.5	58	4.97	111
30	.....do	28.7	37	5.02	132

Daily gage height, in feet, of Fremont River near Thurber, Utah, for 1909.

[John Smith, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		4.7	4.4	4.65	5.55	5.8	5.35	5.55
2		4.75	4.5	4.7	6.0	5.85	5.3	5.6
3		4.8	4.55	4.7	6.1	5.9	5.25	5.65
4		4.8	4.6	4.65	5.9	5.85	5.25	5.6
5		4.85	4.6	4.7	5.9	5.8	5.2	5.5
6		4.85	4.6	4.8	5.85	5.8	5.0	5.6
7		4.9	4.6	4.9	5.9	5.75	5.1	5.5
8		5.0	4.55	5.25	5.8	5.8	5.15	5.45
9		5.0	4.6	5.2	5.75	5.75	5.2	5.5
10		5.05	4.6	5.15	5.6	5.65	5.2	5.55
11		4.95	4.65	5.1	5.7	5.7	5.25	5.5
12		4.8	4.7	6.0	5.8	5.6	5.3	5.55
13	4.25	4.6	4.65	5.5	5.85	5.55	5.35	5.55
14	4.6	4.6	4.75	5.4	5.9	5.5	5.4	5.6
15	4.65	4.55	4.6	6.2	5.8	5.5	5.4	5.7
16	4.5	4.65	4.6	6.25	5.75	5.45	5.45	5.65
17	4.5	4.4	4.65	6.3	5.65	5.4	5.4	5.7
18	4.7	4.6	4.65	6.25	5.6	5.45	5.45	5.75
19	4.8	4.6	4.7	6.3	5.5	5.5	5.5	5.8
20	4.9	4.7	5.1	6.25	5.45	5.4	5.45	5.9
21	4.9	4.7	5.0	6.1	5.3	5.35	5.4	5.85
22	4.9	4.75	4.9	6.0	5.4	5.3	5.45	5.8
23	4.8	4.7	4.95	5.9	5.35	5.25	5.5	5.75
24	4.75	4.65	4.9	5.8	5.4	5.3	5.45	5.8
25	4.8	4.45	4.9	5.7	5.4	5.35	5.5	5.75
26	4.75	4.35	4.95	5.6	5.4	5.4	5.5	5.7
27	4.6	4.5	4.9	5.6	5.35	5.5	5.55	5.65
28	4.7	4.5	4.85	5.5	5.5	5.45	5.5	5.7
29	4.5	4.5	4.7	5.25	5.6	5.4	5.55	5.75
30	4.5	4.5	4.75	5.0	5.7	5.45	5.6	5.7
31	4.55		4.7	5.5		5.4		5.7

Daily discharge, in second-feet, of Fremont River near Thurber, Utah, for 1909.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	136	71	83	185	207	153	171
2	....	140	78	88	235	213	148	176
3	....	144	82	88	240	218	143	181
4	....	143	86	83	223	213	143	176
5	....	145	86	88	223	209	138	166
6	....	143	86	96	218	209	143	176
7	....	145	86	106	223	202	128	166
8	....	154	81	139	212	209	133	161
9	....	152	85	134	207	201	138	166
10	....	154	85	128	191	190	138	171
11	....	142	88	119	202	196	142	166
12	....	127	92	226	213	185	149	171
13	116	107	88	165	218	180	152	171
14	150	105	97	156	223	175	157	176
15	145	100	84	228	213	175	157	174
16	137	108	83	244	207	169	162	179
17	136	85	87	251	194	163	157	174
18	150	100	87	246	189	169	162	189
19	163	100	91	253	179	175	168	195
20	172	108	128	248	174	163	162	205
21	171	107	119	234	159	158	157	200
22	170	111	110	226	169	153	162	195
23	168	105	113	216	164	148	167	189
24	153	99	109	207	169	153	162	195
25	156	81	109	198	169	158	167	189
26	150	70	112	189	169	163	167	184
27	134	83	107	190	164	164	172	179
28	141	82	102	179	179	169	167	184
29	121	81	89	154	189	163	172	189
30	120	67	93	132	189	163	176	184
31	120	....	89	184	....	163	....	184

NOTE.—These discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Fremont River near Thurber, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May 13-31	172	116	146	5,500	D.
June	154	67	114	6,780	C.
July	128	71	93.6	5,760	B.
August	253	83	170	10,500	B.
September	240	159	196	11,700	C.
October	218	148	180	11,100	C.
November	176	128	155	9,220	C.
December	205	161	180	11,100	C.
The period	....	....	....	71,600	

MUDDY CREEK NEAR EMERY, UTAH.

Muddy Creek rises in the eastern slopes of the Wasatch Mountains in the extreme southern corner of Sanpete County and joins Curtis Creek about 8 miles below Emery, Utah. Curtis Creek flows southeasterly across Emery County and enters Fremont River near Hawksville, Utah.

The station was originally established April 29, 1909, at Jacobson's ranch, about 7 miles above and northwest of the town of Emery, Utah.

The station is below all tributaries and above all diversions.

Prior to August 25, 1909, records were obtained by measuring down to the water surface from a reference point on a flume in which discharge measurements were made. A staff gage was installed at the same location and datum on August 25. During August great variations in discharge were caused by heavy rains, which washed out the gage and so altered the section that the station had to be reestablished at a new location September 18 several hundred feet upstream. A staff gage was installed at a different datum and a cable erected, from which cable section discharge measurements will be made.

Discharge measurements of Muddy Creek near Emery, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 13	E. A. Porter	24	41	3.40	247
Aug. 25	.....do	17	15	1.90	48
Sept. 18	.....do	17	18	[a]1.98	55
Dec. 3[b]	.....do			[a]1.20	[c]3.8

[a] Gage height from new gage set Sept. 18 at a different location and datum from the one previously used.
[b] Creek frozen over along the entire course; 6 inches of ice at gage.
[c] Estimated.

Daily gage height, in feet, and discharge, in second-feet, of Muddy Creek near Emery, Utah, for 1909.

[Melvin Sorenson, observer.]

Day.	April.		May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
1			1.85	44	3.25	224	2.75	153	2.35	
2			1.95	53	3.75	300	2.7	146	2.3	
3			2.5	119	3.7	292	2.55	126	2.2	
4			2.7	146	3.75	300	2.5	119	2.3	
5			2.6	132	3.7	292	2.35	100	2.3	
6			1.4	12	3.7	292	2.35	100		
7				15	3.6	277	2.3	94	2.1	
8				18	3.65	284	2.3	94	2.05	
9				21	3.5	262	2.25	88		
10			1.6	24	3.5	262	2.25	88		
11			1.95	53	3.5	262	2.45	112		
12			2.45	112	3.45	254	2.5	119		
13			2.5	119	3.5	262	2.5	119	2.1	
14			2.5	119	3.45	254	2.45	112	2.0	
15			2.4	106	3.45	254	2.45	112	2.0	
16			2.95	181	3.45	254	2.4	106	2.0	
17			3.45	254	3.45	254	2.4	106		
18			3.55	270	3.35	240	2.45	112		
19			3.25	224	3.35	240	2.45	112		
20			3.00	188	3.35	240	2.45	112		
21			3.3	232	3.3	232	2.45	112		
22			3.05	195	3.3	232	2.4	106		
23			3.0	188	3.2	217	2.5	119		
24			2.9	174	3.2	217	2.45	112	2.1	
25			3.15	210	3.15	210	2.45	112	1.9	
26			3.7	292	3.1	202	2.45	112	1.9	
27			3.25	224	3.1	202	2.35	100	1.9	
28			3.2	217	3.0	188	2.35	100	1.9	
29	1.9	48	3.1	202	2.95	181	2.35	100	1.9	
30	1.8	40	2.9	174	2.8	160	2.3	94		
31			3.1	202			2.3	94		

NOTE.—The daily discharges are based on a rating curve that is fairly well defined between 40 and 300 second-feet.

Monthly discharge of Muddy Creek near Emery, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
May	292	12	146	8,980	B.
June	300	160	245	14,600	A.
July	153	88	109	6,700	A.

ESCALANTE RIVER BASIN.

ESCALANTE CREEK NEAR ESCALANTE, UTAH.

Escalante River rises in the southern part of Garfield County, Utah, under the walls forming the east face of the Table Cliff Plateau; flows first northeast, then east, and finally southeast, and enters the Colorado in Kane County about 12 miles above the mouth of the San Juan. It is 90 miles long, and the lower three-fourths of its course is through a narrow canyon whose vertical walls range in height from 900 to 1,200 feet. Through this gorge the river sweeps, in places filling the whole space from wall to wall, in places winding from side to side in a flood plain of sand and shifting its position more or less with every freshet.

In the upper part of its course it is joined by several tributaries, all of which flow through close canyons.

A gaging station, established August 5, 1909, is located on Escalante Creek, one of the headwaters of Escalante River, at the head of the canyon, about 2 miles below the town of Escalante, Utah. The records show the total amount of water available for storage in an excellent reservoir site at this point.

The principal tributaries above are Birch Creek, entering about 6 miles upstream, and Pine Creek, which enters just above the station. Practically all the normal low-water flow is diverted above the station for irrigation in and near Escalante, the run-off at the station representing only the surplus water.

Estimates of winter discharge are very unreliable. The shifting nature of the stream bed makes accurate interpretation of the results difficult.

The first gage used was located about 20 feet below the mouth of Pine Creek. It was washed out by a severe flood August 31, which scoured out the bed of the creek about 3 feet and changed the location of the channel. From September 1 to November 12 records were kept of the depth of water at a point near the gage site. On November 13 a new gage was set 35 feet above the old one and the observer's readings for the intervening period referred to the new datum. The records for this period are only approximate.

Discharge measurements of Escalante Creek near Escalante, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Aug. 5[a]	E. A. Porter			1.85	8.0
Nov. 13[b]	do	11	7.9	2.06	13.5

[a] Made by floats, coefficient 0.8 used.
[b] Made by wading below gage installed this date at different datum.

Daily gage height, in feet, of Escalante Creek near Escalante, Utah, for 1909.

[D. C. Shurtz, observer.]

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.7	2.2		2.0	16	6.2	2.0	1.6	2.0	
2		4.7		1.8		17	2.0			2.0	2.6
3		3.2	2.15		2.0	18	5.2	2.2	1.55		2.0
4		4.1		1.8		19	3.5			2.0	2.4
5	1.8		2.2		2.0	20	2.7	2.1	1.8		
6	1.9	2.0		1.8		21	3.7			2.0	2.6
7	3.7	3.55	2.2		2.05	22	2.1	2.1	1.8		
8	1.6	2.0		1.8		23	2.5		1.8	2.0	2.8
9	3.1		1.75		2.1	24	3.3	2.2			
10	1.8	2.1		2.2		25			1.75	2.0	3.1
11	1.75	2.0	1.7		2.1	26	2.4	2.15			
12		2.0	1.75	1.9		27			1.75	2.0	3.1
13	1.9	2.0	1.65	2.0	2.2	28	2.8	2.2			
14	1.7		1.6			29	8.2		1.75	1.95	3.05
15		2.0		2.0	2.3	30	4.7	2.3			
						31	10.2		1.75		3.15

NOTE.—Gage heights Aug. 5 to 31 refer to gage installed Aug. 5. Gage heights Sept. 1 to Nov. 12, reduced to datum of new gage installed Nov. 13 and are approximate. See description.

Daily discharge, in second-feet, of Escalante Creek near Escalante, Utah, for 1909.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1		127	18	6	12	16	443	12	3	12	29
2		243	17	7	12	17	12	15	2	12	36
3		79	16	7	12	18	304	18	2	12	12
4		170	17	7	12	19	107	16	4	12	26
5	7	91	18	7	12	20	42	15	7	12	31
6	9.5	12	18	7	13	21	127	15	7	12	36
7	127	112	18	7	14	22	15	15	7	12	42
8	3	12	12	7	14	23	31	16	7	12	48
9	70	14	6	12	15	24	88	18	6	12	50
10	7	15	6	18	15	25	57	17	6	12	70
11	6	12	5	14	15	26	26	16	6	12	70
12	8	12	6	9.5	16	27	37	17	6	12	70
13	9.5	12	4	12	18	28	48	18	6	12	68
14	5	12	3	12	20	29	520	20	6	11	66
15	112	12	3	12	22	30	243	22	6	11	70
						31	670		6		74

NOTE.—These discharges are based on a rating curve that is not well defined.

Monthly discharge of Escalante Creek near Escalante, Utah, for 1909.

Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).
August 5-31	116	6,210
September	39.5	2,350
October	8.19	504
November	10.8	643
December	33.2	2,040

NOTE.—These estimates are only approximate. See description.

SAN JUAN RIVER BASIN.

DESCRIPTION.

San Juan River rises among the snow masses that crown the high peaks of the San Juan Mountains in southwestern Colorado, flows southwestward into New Mexico, then swings to the west and northwest, passing from San Juan County, N. Mex., across the extreme southwestern corner of Colorado into San Juan County, Utah, in the southwestern part of which it unites with the Colorado.

For the first 75 miles of its course the San Juan is a typical mountain stream, but at Canyon Largo, N. Mex., where it turns westward, its character changes, and it occupies a broad, winding, sandy channel in an arid valley, bordered on each side by terraced mesas. Below the mouth of Mancos River the valley narrows and the river bottom is bounded by abrupt bluffs, broken and cut by dry water channels, and merging farther on into the walls of a deep, narrow, box canyon, in which the river flows to its end.

The drainage area includes portions of four States and Territories. Its topography ranges from the mountainous types at the headwaters in Colorado to the types exemplified in the valleys, plateaus, and eroded mesas of Utah, New Mexico, and Arizona. Large areas of eruptive rocks occur in the highest portions of the basin, but the predominating formations are of sedimentary origin. The headwater streams are protected by fine forests of spruce and yellow pine and at lower elevations large areas of aspen. The lower basin is practically barren except for an extensive growth of sagebrush, scattered cedars, piñons, and range grasses.

The principal tributaries of the San Juan are Navajo, Piedra, Pine, Florida, Animas, and La Plata rivers, the Animas being the most important.

Animas River has its source in the region above Silverton, draining portions of the Needle and La Plata Mountains, the former being the most rugged of the Rocky Mountain ranges. The river flows southward to the Colorado-New Mexico line and thence southwestward to the point where it joins the San Juan at Farmington, N. Mex. The upper portion of the basin, above Durango, is very mountainous and furnishes the principal part of the run-off. Much of this region is well timbered with pine, spruce, and aspen, but large areas consist of naked granite peaks. Immediately above and below Durango the valley broadens and is bordered by mesas and bluffs cut by narrow canyons and covered with sagebrush and scattered pines and piñons; along the stream channels cottonwoods predominate. The rocks of this region are chiefly of sedimentary origin. The soils of the lower valleys consist of sandy loam and are very fertile.

La Plata River rises in the granite masses known as La Plata Mountains, about 25 miles northwest of Durango, Colo., and flows southward to its point of junction with the San Juan. Its drainage basin is a narrow strip parallel to and adjoining the Animas basin. The upper portion of the basin is a well-watered and forest-clad mountain region which merges southward into an arid mesa, plateau, and canyon country. La Plata Valley proper is a narrow, shallow depression from Hesperus down, bounded on both sides by high, broken tablelands and deeply eroded mountains. The lower mountain slopes are covered with piñon, scrub oak, and cedar; the lower valleys support heavy growths of sagebrush and chico; the upper mountain slopes were at one time heavily timbered with spruce and yellow and white pine, but these forests have been largely removed by lumbermen.

The other tributaries of the San Juan need not here be described. Those mentioned are perennial streams, but much of their water is diverted for irrigation and never reaches the main river. In addition to the perennial streams are many intermittent creeks throughout New Mexico, which contribute large volumes of water during heavy storms.

The altitudes in this drainage basin range from over 13,000 feet in the highest mountains to between 6,000 and 7,000 feet at the Colorado-New Mexico line. The San Juan at the mouth of the Animas has an elevation of about 5,300 feet; at its junction with Colorado River the elevation is about 3,500 feet.

Most of the timbered land in the San Juan drainage basin is included in the San Juan National Forest, which contains nearly 2,000 square miles of merchantable timber, 100 square miles of woodland, 300 square miles of sagebrush, and 200 square miles of barren and burnt area.

In a small area in the high mountains the annual precipitation exceeds 25 inches, and over a considerable area the average exceeds 20 inches; but for the remainder of the area the average in Colorado seems to be about 15 inches, that in New Mexico about 10 inches, and in Utah about 15 inches.

Above an altitude of 7,500 feet the winters are severe and snowfalls are heavy; below an elevation of 6,000 feet the winters are comparatively open and mild. The upper mountain streams flow under a thick ice cover, but in the more open country, in the vicinity of Aztec, it is rather unusual for the rivers to freeze over entirely, though much ice forms along the edges, and slush ice is often seen.

Much land along the valleys of San Juan, Animas, Pine, Florida, and La Plata rivers and the smaller tributaries in Colorado is now under cultivation, and also a few thousand acres of valley land in New Mexico. Up to this time irrigation has largely been confined to the bottom land. The greatest opportunities for future development are in San Juan County, N. Mex., where exceptionally large areas, aggregating probably a million acres of fertile lands, are excellently adapted to irrigation. The rivers there are bordered by broad mesas and benches, sloping back for miles in many places and easily reached by irrigation canals, and the water supply is ample.

Numerous small lakes, high up in the mountains, tend to equalize the flow of some of the tributaries, and many large and small storage reservoir sites are available. Among others may be mentioned the Turley reservoir site, on San Juan River below the mouth of the Pine, which has a storage capacity of about one and a half million acre-feet.

Excellent opportunities for power development are presented. Theoretically, with proper storage, it will be possible to develop nearly 300,000 horsepower. Falls of 100 to 300 feet per mile are common on the upper reaches of the stream. The San Juan has an average fall of about 13 feet to the mile from the mouth of the Piedra to the mouth of the Mancos, a distance of about 115 miles, while the fall above the mouth of the Piedra is very much greater. The Animas has a fall of over 70 feet to the mile from Silverton to Durango, a distance of about 40 miles, and from Durango to its mouth the average fall is over 20 feet to the mile. Present developments are practically limited to two power plants on Animas River, of 6,000 and 1,000 horsepower. Several other plants are contemplated.

The largest deposits of lignite and bituminous and coking coal in the West are in this drainage area.

FLOOD IN SAN JUAN VALLEY, SEPTEMBER 5 AND 6, 1909.[1]

GENERAL FEATURES.

A very heavy flood occurred on the San Juan and its tributaries in southwestern Colorado and northwestern New Mexico on September 5 and 6, 1909. The oldest residents in the vicinity of Aztec and Farmington stated that both the Animas and San Juan reached higher stages during this flood than at any time since the country has been settled, and even the Indians are said to have had no memory of a time when the San Juan was so high.

The flood was caused by continuous heavy rains in the headwater region and all along the courses of these streams. The upper San Juan itself and its tributaries from the north, from the Piedra west to and beyond La Plata, were in flood simultaneously with Canyon Largo and other large intermittent tributaries from the south, all of which are capable of carrying enormous quantities of water. The main watercourse of Canyon Largo, for instance, is more than 70 miles long, and some of its tributaries are 40 or 50 miles long, so that it drains a very large area which at times is subject to an excessive run-off. The combined floods caused the usual damage.

---

[1] This report by Mr. Freeman was also published in the Monthly Weather Review for September, 1909.

In Colorado the Denver & Rio Grande Railroad sustained the greater part of the loss. Along Animas River between Silverton and Durango many stretches of the railroad tracks were washed out and others were covered with immense deposits of sediment. Traffic on this branch was suspended for about three weeks. The cost to the railroad company amounted to many thousand dollars. Animas River also did considerable damage in the town of Durango and surrounding country.

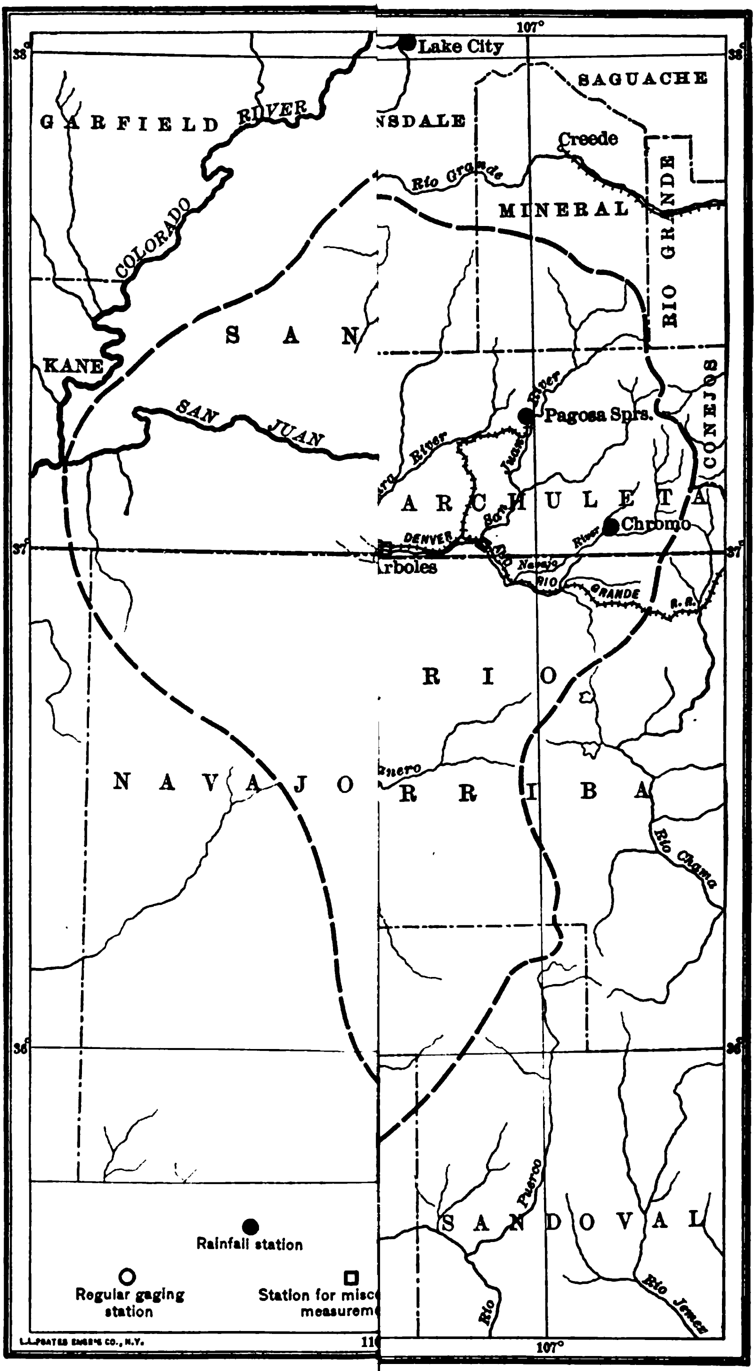
Pine River, in Colorado, was in heavy flood and overflowed its banks in many places. At La Boca, the river took out the approach embankment to railroad bridge on right bank. This embankment has since been replaced by a pile span. Spring Creek, which flows into Pine River near this point, washed out the railroad track in several places. A locomotive went into the ditch at a small railroad trestle on this creek. The Piedra and upper San Juan were also at very high stages.

In San Juan County, N. Mex., the principal loss was sustained by the Farmington branch of the Denver & Rio Grande Railroad; by the county, through the washing out of the suspension bridge across the San Juan at Blanco; and by the farmers, whose lands were overflowed by the flood waters of Animas and San Juan Rivers. The total loss in the county is believed to have been not less than $20,000; the Blanco bridge alone cost about $4,200. The Flora Vista glade, which runs into Animas River near Flora Vista, carried a great deal of water and sediment and did not a little damage to the railroad track and the surrounding country, both by washouts and by the deposition of sediment. Other glades and arroyos were correspondingly high, though most of them are not in a position to do much damage. The streams in this section began to rise rapidly on Sunday, September 5, and by Sunday night they were at high stages. Maximum heights were attained early Monday morning in the vicinity of Farmington.

PRECIPITATION.

The rainfall was general. (See Pl. VI.) As far west as Fruitland there was about 0.7 inch of precipitation during the first six days of September, most of which fell on the 6th; and as far east as Chama, the rainfall amounted to 1.6 inches from September 1 to 6. At Durango, Colo., the rainfall was 3.6 inches during the above period, of which 1.64 inches fell on September 5 and 0.82 inch on September 6. The combined precipitation on September 5 and 6 at several points was as follows:

	Inches.
Silverton	2.50
Hesperus	2.68
Mancos	1.41
Ignacio	.87
Pagosa Springs	1.87


107°
38°
Lake City
SAGUACHE
GARFIELD
RIVER
NSDALE
Creede
Rio Grande
MINERAL
RIO GRANDE
COLORADO
SAN
KANE
SAN JUAN
Pagosa Sprs.
San Juan River
River
CONEJOS
ARCHULETA
Chromo
DENVER AND RIO GRANDE R. R.
Navajo River
Arboles
37°
RIO ARRIBA
NAVAJO
nero
Rio Chama
36°
SANDOVAL
Puerco
Rio
Rio Jemez
Rainfall station
Regular gaging station
Station for misc measurem
L.L. POATES ENGR'G CO., N.Y.
11

MA

San Miguel River was in heavy flood at this same time, and the bursting of the Trout Lake reservoir dam caused the destruction of a great deal of property below. Several miles of railroad track were damaged or entirely washed away, causing the suspension of traffic for a long period, and no little damage was done to highways and bottom lands in San Miguel County, Colo.

The following table shows the daily precipitation at various points in San Juan County from September 1 to 7, inclusive:

Precipitation in inches in San Juan drainage basin, September 1–7, 1909.

Stations.	September—							Total.
	1	2	3	4	5	6	7	
Silverton, Colo	0.23	0	0	0.31	2.00	0.50	0.30	3.34
Lake City, Colo	0	T.	.10	.05	.60	.09	.02	.86
Dolores, Colo	.11	.16	0	.10	.41	.48	0	1.26
Hesperus, Colo	.40	.06	.15	.04	1.99	.69	.29	3.62
Durango, Colo	.50	.19	.04	.37	1.64	.82	.01	3.57
Ignacio, Colo	.06	T.	T.	.04	.50	.37	.12	1.09
Chromo, Colo	.15	.03	.27	.18	.79	.37	.30	2.09
Mancos, Colo	0	.13	.29	.04	.99	.42	T.	1.87
Pagosa Springs, Colo	.01	0	.18	.30	1.40	.47	.35	2.71
Bloomfield, N. Mex	0	0	0	0	1.00	.17	0	1.17
Fruitland, N. Mex	T.	T.	0	0	.30	.65	0	.95
Fort Wingate, N. Mex	.40	0	.32	1.20	.59	1.20	0	3.71

SAN JUAN RIVER PROPER.

At Arboles, Colo., above the most important tributaries, the San Juan was at a very high stage and probably reached its maximum on Sunday night. At Blanco, N. Mex., above Canyon Largo, the gage read 10 feet on Sunday evening, and at 6 a. m. Monday, September 6, when the county suspension bridge was washed out, the maximum gage height was about 11 feet. The maximum discharge there was not less than 15,000 second-feet. At Bloomfield, 12 miles below the mouth of Canyon Largo, the river had a flood cross section of 1,800 square feet and a maximum discharge estimated from 18,000 to 20,000 second-feet. The river overflowed the bottom lands all along its course, and in many places the course of the channel was entirely changed. At one place part of an orchard was washed into the river, and at another a house was carried away when the bank caved in. At the county bridge at Farmington, below the mouth of the Animas, the river reached a maximum height late Monday evening. The gage height was in the neighborhood of 12.3 feet on the old United States Geological Survey gage, the cross sectional area was 3,200 square feet, and the estimated discharge was not less than 35,000 second-feet. At this place the river overflowed the right bank for a distance of about 100 yards beyond the end of the bridge, but the bridge was not damaged in any way.

ANIMAS RIVER.

At Durango, Animas River reached a maximum height of 8.50 feet at the power company's gage between 4 and 6 o'clock Monday morning, September 6 (Pl. VII, *B*). The maximum discharge was estimated to be over 10,000 second-feet. Between 6 and 7 o'clock on Monday evening the maximum height of 11 feet was reached on the United States Geological Survey gage at Aztec, N. Mex., and between 10 and 11 p. m. the maximum gage height at the old United States Geological Survey gage at Farmington was 11.1 feet. At Aztec (Pl. VII, *A*) the river overflowed the right bank for a distance of 800 feet beyond the end of the suspension bridge, the water being from 0.5 foot to 2 feet in depth; and at Farmington the river was over its right bank for a distance of a quarter of a mile; the fair grounds and race track there were entirely submerged.

The flood cross section at Aztec was about 3,100 square feet, and the estimated discharge was 16,000 second-feet. At Farmington the maximum discharge was probably from 18,000 to 20,000 second-feet.

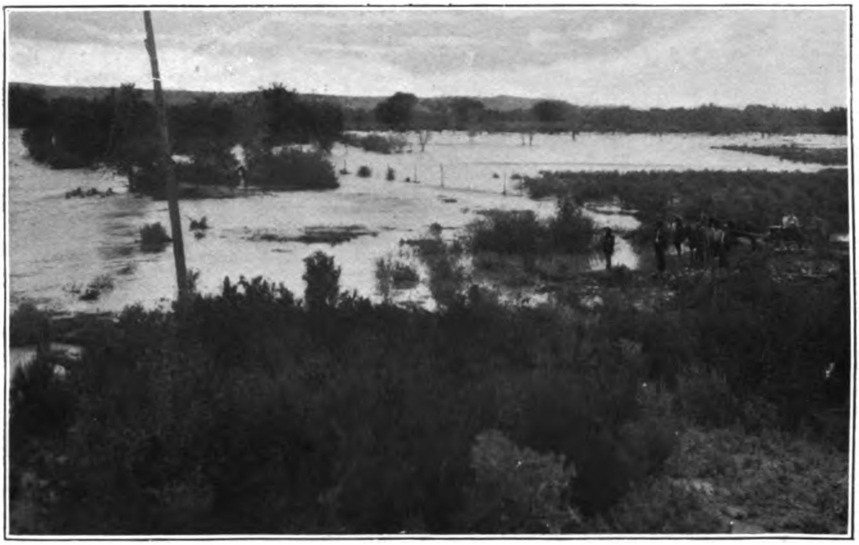
LA PLATA RIVER.

La Plata River attained a maximum gage height of 7.60 feet on the United States Geological Survey and Territorial engineer's gage at La Plata, N. Mex., on Sunday night, September 5, and it is estimated that the maximum discharge was from 6,000 to 7,000 second-feet. The left bank was overflowed for a distance of 1,000 feet, and the cross-sectional area of the overflow was 1,300 square feet, while the cross-sectional area of the main channel was only 224 square feet. It is estimated that the channel under the bridge at La Plata carried a maximum of 3,000 second-feet, while the overflow amounted to as much or more than that amount.

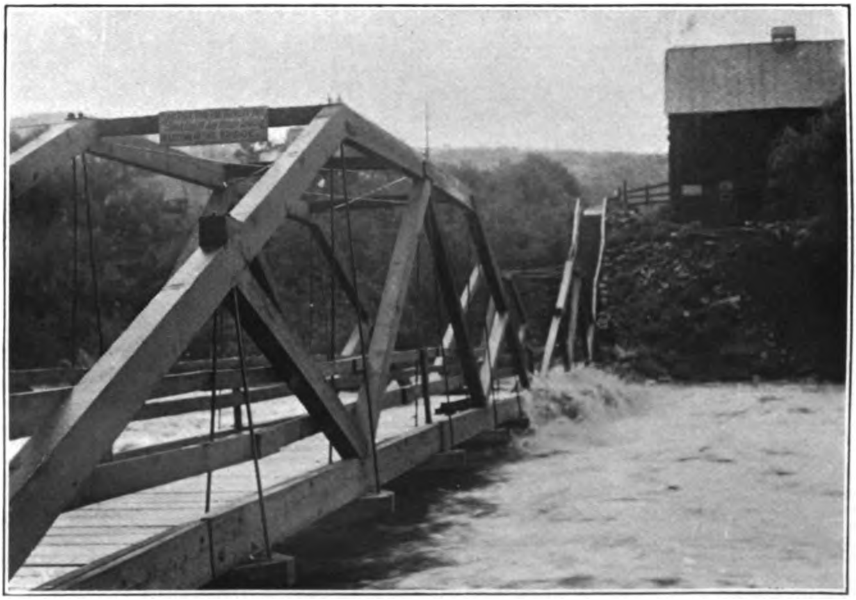
RÉSUMÉ.

During this flood on the San Juan River probably over 150,000 acre-feet of flood waters went to waste and were allowed to do a great deal of damage to the surrounding country. Had these waters been properly stored in any of the numerous reservoirs contemplated in San Juan County, such as the proposed San Juan reservoir, all of this damage could have been prevented and the waters used for the irrigation of a large area.

It is true that a flood of this magnitude is not liable to occur for a number of years, and it is also true that it is not necessary to store these excessive flood waters for irrigation. The San Juan is a valuable stream and its normal flow is ample for the irrigation of all the lands which it will be possible to put under cultivation for a



A. OVERFLOW OF LEFT BANK IN VICINITY OF GAGING STATION AT AZTEC, N. MEX.



B. VIEW AT FOOTBRIDGE NEAR DURANGO POWER PLANT, DURANGO, N. MEX.

FLOOD ON ANIMAS RIVER, SEPTEMBER 6, 1909.

number of years to come. Some storage, however, is necessary on the San Juan, as on any other river in the West. In the latter part of September, 1909, the flow of the San Juan above the mouth of the Animas was only 1,100 second-feet, and that of Animas River at Aztec 800 second-feet. These flows are considerably above the normal for that priod of the year.

SAN JUAN RIVER AT BLANCO, N. MEX.

This station was established December 9, 1908, to take the place of the station at Turley, which was discontinued November 30, 1908. It was located at a new suspension bridge, which crossed the San Juan at Blanco, about 4 miles below Turley post office, 16 miles southeast of the Denver & Rio Grande Railroad at Aztec, N. Mex., and half a mile above the mouth of Canyon Largo.

The suspension bridge and chain gage were washed out by a flood on September 6, 1909, and on September 29, 1909, a temporary staff gage was established about 30 feet upstream from location of the bridge and at a new datum. Discharge measurements after September 6, 1909, were taken at the suspension bridge at Bloomfield about 9 miles downstream, where a wire gage was installed on September 28, 1909. The flow of the river at Blanco and Bloomfield should be the same except for the inflow of Canyon Largo. This stream carried practically no water in the days when discharge measurements were taken between September 28, 1909, and December 31, 1909.

Discharge measurements of San Juan River at Blanco, N. Mex., in 1908–9.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1908.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Dec. 10[a]	J. B. Stewart	194	194	2.60	157
1909.					
Jan. 11	C. D. Miller	210	298	2.80	526
Mar. 30	J. B. Stewart	238	507	4.40	2,010
May 14	.....do	246	915	6.00	5,820
June 26	V. L. Sullivan	246	1,060	6.70	5,970
July 27	J. B. Stewart	243	794	5.80	4,020
Sept. 28[b]	W. B. Freeman	....	....	[c]4.70	1,100
Nov. 17[b]	J. B. Stewart	....	....	[d]4.20	435

[a] Some slush ice.
[b] Measurement made at Bloomfield.
[c] New rod gage installed Sept. 29, 1909, at different datum.
[d] Observer's gage reading at Blanco.

Daily gage height, in feet, of San Juan River at Blanco, N. Mex., for 1909.

[Cleofes Valdes, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.8	2.5	3.3	4.1	5.1	5.5	5.7	4.5	6.8	4.6	4.3	4.2
2	2.8	2.6	3.7	4.85	5.1	5.4	5.6	4.7	6.4	4.6	4.3	4.2
3	2.8	2.9	3.9	5.6	5.5	5.9	5.6	4.6	6.0	4.6	4.3	4.2
4	2.8	2.9	4.3	5.6	6.0	6.6	5.5	4.7	7.2	4.5	4.2	4.3
5	2.8	2.9	4.4	4.8	6.4	7.2	5.7	5.3	8.55	5.6	4.2	4.2
6	2.8	2.8	4.6	4.55	6.6	7.6	5.7	4.7	a9.85	5.6	4.2	4.2
7	2.9	2.8	4.4	4.1	6.7	7.7	5.6	4.6	....	6.1	4.2	4.2
8	2.8	2.8	4.7	4.1	6.8	7.6	5.2	4.6	....	5.2	4.2	4.2
9	2.9	2.9	4.7	3.85	6.65	7.8	5.2	4.5	....	5.1	4.2	4.2
10	2.9	2.7	3.6	3.95	6.3	7.2	5.0	4.2	....	4.9	4.2	4.2
11	2.7	2.7	3.3	4.7	6.1	7.0	4.8	4.5	....	4.8	4.2	4.2
12	2.6	2.7	3.3	4.7	6.0	6.9	4.7	4.8	....	4.8	4.2	4.2
13	2.6	3.0	3.4	4.5	5.9	6.9	4.5	4.3	....	4.8	4.2	4.2
14	2.6	2.9	3.4	4.8	6.0	6.8	4.6	4.1	....	4.7	4.2	4.1
15	2.7	2.9	3.7	6.0	6.0	6.7	4.5	4.8	....	4.7	4.2	4.1
16	2.8	2.8	4.2	6.45	6.05	6.8	4.4	4.8	....	4.7	4.2	4.1
17	3.0	2.8	4.7	7.25	6.1	6.8	4.2	4.8	....	4.6	4.2	4.1
18	2.9	2.9	4.8	7.3	6.1	7.1	4.2	4.5	....	4.6	4.1	4.1
19	2.8	2.9	4.4	7.3	6.4	6.9	4.2	5.9	....	4.6	4.1	4.1
20	2.8	3.3	4.5	6.85	6.2	7.0	4.0	5.9	....	4.6	4.3	4.1
21	2.9	2.9	4.5	6.05	6.2	7.0	4.3	6.7	....	4.5	4.4	4.2
22	3.3	2.6	4.2	5.6	6.0	6.5	4.4	6.0	....	4.4	4.4	4.2
23	3.6	2.5	4.7	5.5	5.85	6.4	6.0	5.9	....	4.4	4.4	4.2
24	3.6	2.3	4.2	5.2	5.8	6.4	5.8	5.8	....	4.4	4.3	4.2
25	3.5	2.9	4.5	5.0	5.6	6.4	5.5	6.5	....	4.4	4.3	4.2
26	3.3	2.8	4.7	4.9	5.6	6.5	4.9	6.3	....	4.4	4.3	4.2
27	3.0	3.0	4.6	5.2	5.5	6.2	5.5	7.5	....	4.4	4.2	4.2
28	2.6	3.3	4.4	5.8	5.55	5.9	5.3	5.8	4.7	4.4	4.2	4.3
29	2.6	....	4.4	5.6	5.9	5.9	4.9	7.1	4.7	4.4	4.2	4.3
30	2.6	....	4.2	5.4	5.7	5.9	4.6	7.4	4.6	4.4	4.2	4.3
31	2.6	....	4.2	....	5.5	....	4.6	7.0	....	4.4	....	4.3

a Estimated maximum gage height of 11.0 feet.

Daily discharge, in second-feet, of San Juan River at Blanco, N. Mex., for 1908-9.

Day.	Dec.	Day.	Dec.	Day.	Dec.
1908.		1908.		1908.	
1	....	11	165	21	270
2	....	12	90	12	300
3	....	13	90	23	450
4	....	14	90	24	450
5	....	15	210	25	350
6	....	16	400	26	350
7	....	17	100	27	300
8	....	18	400	28	300
9	165	19	280	29	250
10	165	20	280	30	320
				31	320

Daily discharge, in second-feet, of San Juan River at Blanco, N. Mex., for 1908-9—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	410	230	650	1,530	3,350	4,390	3,250	1,480	7,050	950	570	470
2	420	280	1,060	2,820	3,350	4,110	3,100	1,800	5,770	950	570	470
3	425	450	1,280	4,670	4,390	5,560	3,100	1,540	4,560	950	570	470
4	435	450	1,840	4,670	5,860	7,820	2,880	1,800	8,400	830	480	550
5	440	450	2,000	2,720	7,140	10,000	3,330	2,850	......	2,400	480	470
6	450	380	2,350	2,260	7,820	11,500	3,330	1,800	......	2,400	480	470
7	550	380	2,000	1,530	8,170	11,900	3,200	1,540	......	3,400	480	470
8	475	380	2,530	1,530	8,520	11,500	2,400	1,540	......	1,700	480	470
9	570	450	2,530	1,190	8,000	12,300	2,400	1,480	......	1,550	460	470
10	575	300	900	1,320	6,810	10,000	2,050	1,080	......	1,250	460	470
11	450	300	610	2,530	6,170	9,100	1,720	1,480	......	1,150	460	470
12	370	300	610	2,530	5,860	8,570	1,640	1,210	......	1,150	450	470
13	370	500	700	2,170	5,560	8,450	1,350	1,210	......	1,150	450	470
14	370	420	700	2,720	5,860	7,950	1,480	970	......	1,000	450	420
15	425	420	1,010	5,860	5,860	7,500	1,350	1,940	......	1,000	450	420
16	500	350	1,680	7,310	6,020	7,670	1,240	1,940	......	1,000	450	420
17	650	350	2,530	10,200	6,170	7,560	1,010	1,940	......	880	440	420
18	560	400	2,720	10,400	6,170	8,400	1,010	1,480	......	880	380	420
19	490	400	2,000	10,400	7,140	7,600	1,010	4,290	......	880	380	430
20	480	700	2,170	8,700	6,490	7,800	800	4,290	......	880	530	430
21	550	380	2,170	6,020	6,490	7,650	1,140	6,720	......	760	620	500
22	925	200	1,680	4,670	5,860	5,850	1,330	4,560	......	670	620	500
23	1,280	150	2,530	4,390	5,410	5,420	4,530	4,290	......	670	620	500
24	1,280	90	1,680	3,590	5,260	5,250	3,980	4,000	......	670	550	500
25	1,120	360	2,170	3,130	4,670	5,160	3,240	6,100	......	670	550	500
26	890	300	2,530	2,920	4,670	5,350	2,100	5,470	......	670	550	500
27	600	410	2,350	3,590	4,390	4,550	3,280	9,500	......	670	460	500
28	290	650	2,000	5,260	4,530	3,750	2,850	4,000	1,100	670	460	580
29	290	......	2,000	4,670	5,560	3,750	2,120	8,050	1,100	670	460	580
30	290	......	1,680	4,110	4,960	3,750	1,540	9,110	950	670	460	580
31	290	......	1,680	......	4,390	......	1,540	7,700	......	670	......	580

NOTE.—These discharges are based on rating curves applicable as follows: Dec. 9 to 15, 1908, and Mar. 4 to June 9, 1909, not well defined: Dec. 16, 1908, to Mar. 3, 1909, June 10 to Sept. 4, and Sept. 28 to Dec. 31, 1909, indirect method for shifting channels used.

Discharge Sept. 5 and 6 estimated as 9,650 and 13,000 second-feet, respectively. Discharge Sept. 7 to 27 estimated as equivalent to 6,190 second-feet per day by hydrograph comparison with the flow of the Animas River at Aztec, N. Mex.

Monthly discharge of San Juan River at Blanco, N. Mex., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1908.					
December 9-31	450	90	265	12,100	D.
1909.					
January	1,280	290	555	34,100	D.
February	700	90	372	20,700	D.
March	2,720	610	1,750	108,000	B.
April	10,400	1,190	4,310	256,000	B.
May	8,520	3,350	5,840	359,000	B.
June	12,300	3,750	7,340	437,000	C.
July	4,530	800	2,240	138,000	C.
August	9,500	970	3,460	213,000	D.
September	[a]13,000	950	6,050	360,000	D.
October	3,400	670	1,090	67,000	D.
November	620	380	494	29,400	D.
December	580	420	483	29,700	D.
The year	13,000	90	2,830	2,050,000	

[a] Estimated.

ANIMAS RIVER AT AZTEC, N. MEX.

This station was originally established June 21, 1904, at a wooden-truss highway bridge about three-eighths of a mile west of Aztec, N. Mex. It was discontinued December 14, 1904, and reestablished at the same location on June 8, 1907. On September 13, 1908, it was moved to a new suspension bridge about half a mile above the old bridge, which was torn down on completion of the new bridge. The station is about one-third of a mile west of Aztec, on the main wagon road to Farmington and La Plata.

No change in the staff gage or gage datum occurred during the maintenance of the station at the old location. Beginning September 13, 1908, an inclined staff gage, installed a few feet downstream from the suspension bridge at an arbitrary datum, was read.

The station, although 20 miles above the mouth of the river, is below all important tributaries. The drainage is about 1,300 square miles. Between Durango and Aztec many large ditches divert water for irrigation and the discharge at this station does not represent the total run-off of the stream. Notwithstanding numerous existing water rights, an ample supply of water is available for future development.

Ice forms to a considerable depth along the edges during the greater part of the winter, but the river seldom freezes across. Slush ice occurs frequently during the winter months.

Results obtained at this station are good except during and after high water, when the shifting of the channel interferes with the accuracy of the data. The flood of September 6, 1909, made it necessary to use the indirect method for shifting channels in estimating the daily and monthly flow after that date.

Discharge measurements of Animas River at Aztec, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 12[a]	C. D. Miller	75	101	3.30	177
Mar. 29	J. B. Stewart	145	228	4.15	657
May 13	.....do	157	539	6.20	3,070
June 27	V. L. Sullivan	151	731	6.90	4,470
July 28	J. B. Stewart	155	457	5.65	2,010
Sept. 27	W. B. Freeman	150	252	4.65	793
Nov. 16	J. B. Stewart	149	152	4.05	342

[a] Made by wading, not at regular section.

Daily gage height, in feet, of Animas River at Aztec, N. Mex., for 1909.

[H. S. Wattles, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.4	3.5	3.6	4.4	5.1	5.4	6.55	4.65	5.8	4.5	4.8	4.1
2	3.4	3.5	3.8	4.5	5.0	5.8	6.4	4.7	5.3	4.4	4.5	4.1
3	3.4	3.5	4.0	4.6	5.0	6.5	6.3	4.5	5.3	4.4	4.3	4.15
4	3.4	3.5	4.0	4.7	5.4	7.45	6.1	4.5	5.7	4.5	4.2	4.2
5	3.4	3.5	4.1	4.8	6.4	8.3	6.3	4.8	7.85	4.6	4.2	4.2
6	3.4	3.5	4.3	4.6	6.6	8.7	6.35	4.4	10.0	4.65	4.2	4.15
7	3.4	3.5	4.2	4.4	6.7	8.75	6.2	4.35	9.9	4.5	4.1	4.15
8	3.4	3.5	4.2	4.3	6.95	8.7	6.0	4.3	8.25	4.6	4.1	4.1
9	3.4	3.5	4.2	4.3	6.75	8.7	5.7	4.45	7.65	4.5	4.1	4.1
10	3.4	3.5	4.1	4.5	6.3	8.5	5.5	4.35	6.4	4.5	4.1	4.1
11	3.3	3.5	4.0	4.7	6.1	8.25	5.3	4.5	6.0	4.5	4.1	4.0
12	3.3	3.5	3.9	4.7	6.15	7.8	5.2	4.4	6.0	4.4	4.1	4.0
13	3.3	3.5	3.8	4.5	6.1	7.95	5.1	4.5	5.7	4.4	4.1	4.0
14	3.2	3.5	3.8	4.6	6.1	7.8	5.0	4.45	5.6	4.4	4.1	4.0
15	3.3	3.5	3.9	5.1	6.0	7.65	4.9	4.4	5.5	4.4	4.1	4.0
16	3.4	3.5	4.0	5.8	6.0	7.8	4.7	5.5	5.7	4.4	4.1	4.0
17	3.5	3.4	4.1	6.3	6.1	7.9	4.6	5.2	5.7	5.4	4.1	4.0
18	3.4	3.4	4.2	6.6	6.25	8.15	4.5	4.8	5.7	5.4	4.0	4.0
19	3.4	3.4	4.2	6.8	6.65	8.1	4.4	4.8	5.65	5.4	4.0	3.9
20	3.4	3.4	4.4	6.5	6.8	7.95	4.4	4.8	5.6	5.4	4.0	3.9
21	3.5	3.45	4.3	6.0	6.85	7.85	4.5	5.0	5.6	5.4	4.0	3.9
22	3.6	3.45	4.2	5.7	6.2	7.6	4.9	4.8	5.6	5.4	4.0	3.9
23	3.75	3.45	4.5	5.3	6.1	7.55	5.7	4.7	5.6	5.4	4.05	3.9
24	3.5	3.45	4.3	5.0	6.1	7.5	5.85	5.0	5.6	5.35	4.05	3.9
25	3.5	3.45	4.4	4.8	5.8	7.4	5.8	5.3	5.6	5.35	4.05	4.0
26	3.4	3.5	4.5	4.8	5.7	7.2	5.1	5.8	5.0	5.35	4.05	4.0
27	3.3	3.5	4.5	5.25	6.0	7.1	6.0	5.0	4.8	5.3	4.05	4.0
28	3.3	3.5	4.4	5.1	6.8	7.0	5.65	5.2	4.6	5.3	4.1	4.0
29	3.3	......	4.3	5.6	6.8	6.75	5.3	6.2	4.5	5.3	4.1	3.9
30	3.3	......	4.3	5.4	6.1	6.65	5.0	6.5	4.5	5.3	4.1	3.9
31	3.6	......	4.3	......	5.6	......	4.8	6.0	......	5.1	......	4.0

Daily discharge, in second-feet, of Animas River at Aztec, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	235	292	350	858	1,510	1,860	3,690	1,050	2,390	700	830	380
2	235	292	471	930	1,400	2,390	3,410	1,100	1,740	620	640	380
3	235	292	594	1,010	1,400	3,590	3,230	930	1,740	620	500	410
4	235	292	594	1,100	1,860	5,610	2,880	930	2,240	700	450	440
5	235	292	657	1,190	3,410	7,700	3,230	1,190	6,570	750	450	440
6	235	292	788	1,010	3,780	8,780	3,320	858	12,500	800	450	410
7	235	292	721	858	3,980	8,920	3,050	823	12,100	700	390	410
8	235	292	721	788	4,490	8,780	2,710	788	7,450	750	390	380
9	235	292	721	788	4,080	8,780	2,240	894	5,950	680	390	380
10	235	292	657	930	3,230	8,240	1,980	823	3,300	680	380	380
11	180	292	594	1,100	2,880	7,570	1,740	930	2,640	680	380	320
12	180	292	532	1,100	2,960	6,450	1,630	858	2,620	620	380	320
13	180	292	471	930	2,880	6,810	1,510	930	2,190	620	380	320
14	130	292	471	1,010	2,880	6,450	1,400	894	1,900	620	370	320
15	180	292	532	1,510	2,710	6,090	1,290	858	1,770	620	370	320
16	235	292	594	2,390	2,710	6,450	1,100	1,980	2,050	620	370	320
17	292	235	657	3,230	2,880	6,690	1,010	1,630	2,050	1,420	370	320
18	235	235	721	3,780	3,140	7,310	930	1,190	2,050	1,400	310	320
19	235	235	721	4,180	3,880	7,180	858	1,190	1,970	1,400	310	260
20	235	235	858	3,590	4,180	6,810	858	1,190	1,900	1,390	310	260
21	292	264	788	2,710	4,280	6,570	930	1,400	1,800	1,390	310	260
22	350	264	721	2,240	3,050	5,970	1,290	1,190	1,650	1,380	310	260
23	440	264	930	1,740	2,880	5,850	2,240	1,100	1,800	1,380	350	260
24	292	264	788	1,400	2,880	5,730	2,470	1,400	1,780	1,360	350	260
25	292	264	858	1,190	2,390	5,490	2,390	1,740	1,780	1,350	350	330
26	235	292	930	1,190	2,240	5,040	1,510	2,390	1,110	1,340	350	330
27	180	292	930	1,680	2,710	4,820	2,710	1,400	910	1,290	350	330
28	180	292	858	1,510	4,180	4,600	2,180	1,630	760	1,270	380	330
29	180	......	788	2,110	4,180	4,080	1,740	3,050	700	1,250	380	270
30	180	......	788	1,860	2,880	3,880	1,400	3,590	700	1,250	380	270
31	350	......	788	......	2,110	......	1,190	2,710	......	1,100	......	330

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to Sept. 6, fairly well defined between discharges of 130 and 4,600 second-feet. Sept. 7 to Dec. 31, indirect method for shifting channels used.

Monthly discharge of Animas River at Aztec, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	440	130	239	14,700	A.
February	292	235	279	15,500	A.
March	930	350	697	42,900	A.
April	4,180	788	1,660	98,800	A.
May	4,490	1,400	3,030	186,000	A.
June	8,920	1,860	6,150	366,000	A.
July	3,690	858	2,000	123,000	A.
August	3,590	788	1,380	84,800	B.
September	12,500	700	3,000	179,000	C.
October	1,420	620	992	61.090	B.
November	830	310	398	23,700	B.
December	440	260	333	20,500	B.
The year	12,500	130	1,680	1,220,000	

LA PLATA RIVER AT LA PLATA, N. MEX.

This station, which was established May 25, 1905, to obtain data for use by the United States Reclamation Service in connection with their proposed La Plata project, is located at a wooden, single-span highway bridge, about 16 miles northwest of Aztec, N. Mex., and 1 mile south of La Plata post office, in sec. 3, T. 31 N., R. 13 W. of New Mexico principal meridian. Being located below all the principal diversions, the station shows the amount of flood water available for storage and irrigation.

The station is below all tributaries and about 15 miles above the mouth of the La Plata. The drainage area is about 340 square miles.

Nearly all the normal flow of this stream is diverted for irrigation above the station, and there are a few small diversions below.

Thin ice frequently forms across the stream during the winter period, thick ice forms along the edges, and slush ice at times interferes with winter measurements.

On December 9, 1908, a chain gage was installed on the bridge and is read in place of the rod gage, as the latter does not record low stages. The datum remained unchanged.

Because of shifting conditions of channel and the uncertainty of certain gage heights, the results obtained at this station are not good. The discharge measurements and gage heights for 1905 to 1908 for this station have been published in Water-Supply Papers 174, 210, and 248.

The monthly estimates of the flow for 1905 to 1909 are included in this report. The data on which they are based are very meager, and owing to the torrential character of the stream and the extreme low stages during the greater part of each year the estimates given are very approximate and should be used with caution. They are, however, the best interpretation that can be made of the available data.

Discharge measurements of La Plata River at La Plata, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 12	C. D. Miller	7	1.8	1.50	3
Mar. 29	J. B. Stewart	31	30	2.22	54
May 13	do	33	58	3.05	264
June 27	V. L. Sullivan	29	15.1	1.80	12.4
July 26	J. B. Stewart			1.45	[a].8
Sept. 25	W. B. Freeman	32	30	2.30	37
Nov. 16	J. B. Stewart			1.90	[a]1.2

[a] Estimated.

Daily gage height, in feet, of La Plata River at La Plata, N. Mex., for 1909.

[Frank Williams, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.3	1.5	3.4	2.3	2.6	2.35	1.55	1.4	2.9	2.2	2.0	1.55
2	1.3	1.5	3.85	2.4	2.55	2.4	1.5	1.4	2.8	2.2	2.0	1.55
3	1.3	1.6	2.4	2.75	2.6	2.55	1.35	1.4	2.6	2.15	2.0	1.55
4	1.3	1.8	4.45	2.8	2.9	3.05	1.5	1.4	2.5	2.1	2.0	1.55
5	1.3	1.7	3.4	2.8	3.6	3.15	1.5	1.4	7.35	2.1	2.0	1.55
6	1.3	1.6	3.3	2.5	3.6	3.15	1.45	1.4	5.8	2.1	2.0	1.6
7	1.3	1.6	2.2	2.55	3.7	3.35	1.45	1.4	4.5	2.1	1.9	1.6
8	1.4	1.5	2.4	2.5	3.8	3.65	1.45	2.0	3.8	2.1	1.9	1.6
9	1.5	1.4	2.4	2.6	3.1	3.3	1.45	1.4	3.35	2.1	1.9	1.6
10	1.5	1.4	2.3	2.8	3.0	3.2	1.45	1.4	3.0	2.1	1.9	1.6
11	1.5	1.4	2.4	2.8	2.85	2.95	1.45	2.0	2.8	2.1	1.9	1.6
12	1.5	1.3	2.0	2.7	2.95	2.75	1.45	1.4	2.85	2.1	1.9	1.6
13	1.4	1.4	2.4	2.65	3.05	2.75	1.45	1.4	2.8	2.1	1.9	1.65
14	1.5	1.4	2.5	2.8	3.0	2.7	1.45	1.4	2.1	2.1	1.9	1.65
15	1.4	1.6	2.5	3.4	2.85	2.55	1.45	2.5	2.55	2.1	1.9	1.65
16	1.8	1.7	2.3	3.9	2.8	2.55	1.45	2.9	2.6	2.1	1.9	1.65
17	1.65	1.8	2.4	4.35	2.9	2.5	1.45	2.3	2.55	2.1	1.9	1.65
18	1.8	1.7	2.6	4.6	3.15	2.5	1.45	1.8	2.5	2.1	1.9	1.65
19	1.6	1.8	2.4	4.55	2.9	2.45	1.45	2.3	2.45	2.05	1.9	1.65
20	1.6	1.8	2.4	3.9	3.15	2.55	1.45	3.5	2.4	2.0	1.9	1.65
21	1.8	1.7	2.3	3.4	2.8	2.45	1.45	2.4	2.4	2.0	1.9	1.65
22	1.8	1.6	2.2	3.1	2.75	2.35	1.45	2.1	2.35	2.0	1.8	1.65
23	2.0	1.5	2.3	2.9	2.7	2.35	1.45	2.0	2.3	2.0	1.8	1.65
24	1.9	1.5	2.4	2.7	2.55	2.15	1.45	2.1	2.3	2.0	1.8	1.65
25	1.6	1.5	2.2	2.6	2.5	2.95	1.45	3.8	2.3	2.0	1.8	1.65
26	1.4	1.6	2.2	2.55	2.5	2.95	1.45	2.5	2.3	2.0	1.8	1.65
27	1.6	1.7	2.3	2.65	2.5	1.9	1.4	2.7	2.25	2.0	1.2	2.0
28	1.6	2.0	2.5	2.9	2.6	1.75	1.4	2.45	2.2	2.0	1.2	2.0
29	1.5		2.3	2.95	2.7	1.7	1.4	3.1	2.2	2.0	1.55	2.0
30	1.5		2.3	2.6	2.5	1.65	1.4	4.5	2.2	2.0	1.55	2.0
31	1.5		2.3		2.4		1.4	3.2		2.0		2.0

NOTE.—Maximum gage height on Sept. 5, 7.65 feet.

Daily discharge, in second-feet, of La Plata River at La Plata, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.9	3	390	67	127	76	4	.5	156	23	3	0.1
2	.9	3	595	85	116	85	3	.5	130	23	3	.1
3	.9	5.5	85	166	127	116	6	.5	88	19	3	.1
4	.9	12.4	*a* 890	180	212	264	3	.5	70	16	3	.1
5	.9	8.5	390	180	475	300	3	.5	*a* 5,000	15	3	.1
6	.9	5.5	352	105	475	300	2	.5	*a* 1,550	12	3	.1
7	.9	5.5	317	116	520	370	2	.5	920	12	1.5	.1
8	1.5	3	85	105	570	498	2	14	480	12	1.5	.1
9	3	1.5	85	127	282	352	1.5	.5	300	12	1.5	.1
10	3	1.5	67	180	247	317	1.5	.5	184	11	1.5	.1
11	3	1.5	85	180	196	230	1.5	14	130	11	1.5	.1
12	3	.9	52	152	230	166	1.5	.5	142	11	1.5	.1
13	1.5	1.5	85	140	264	166	1.5	.5	130	10	1.5	.1
14	3.	1.5	105	180	247	152	1.5	.5	20	10	1.5	.1
15	1.5	5.5	105	390	196	116	1	70	78	10	1.5	.1
16	12.4	8.5	67	620	180	116	1	156	88	10	1.5	.1
17	7	12.4	85	*a* 850	212	105	1	40	80	9	1	.1
18	12.4	8.5	127	*a* 970	300	105	1	6	70	9	1	.1
19	5.5	12.4	85	*a* 930	212	95	1	40	62	7	1	.1
20	5.5	12.4	85	620	300	116	1	360	54	6	1	.1
21	12.4	8.5	67	390	180	95	.8	70	54	6	1	.1
22	12.4	5.5	52	282	166	76	.8	20	46	6	.5	.1
23	27	3	67	212	152	76	.8	13	40	5	.5	.1
24	18.5	3	85	152	116	45	.8	20	40	5	.5	.1
25	5.5	3	52	127	105	230	.8	500	40	5	.5	.1
26	1.5	5.5	52	116	105	230	.8	70	32	4	.5	.1
27	5.5	8.5	67	140	105	18.5	.5	108	28	4	0	2.5
28	5.5	27	105	212	127	10.4	.5	13	23	4	0	2.5
29	3	....	67	230	152	8.5	.5	216	23	4	.1	2.5
30	3	....	67	127	105	7.0	.5	920	23	4	.1	2.5
31	3	....	67	....	85	....	.5	250	....	3	....	2.5

a Estimated by extension of rating curve. Discharge, approximate.

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 30, not well defined; July 1 to Dec. 31, indirect method for shifting channels. Maximum flood discharge, Sept. 5, gauge height 7.65 feet, estimated by Kutter's formula as 7,000 second-feet.

Monthly discharge of La Plata River at La Plata, N. Mex., for 1905–1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1905.					
May 25-31	565	165	337	4,680	C.
June	817	95	358	21,300	C.
July	107		7.8	480	D.
August	0		0	0	
September	970		64.0	3,810	D.
October	800		79.7	4,900	D.
November	8		1.2	71	D.
December	5	4	4.2	258	D.
The period				35,500	
1906.					
January			[a] 10	615	D.
February			[a] 5.0	278	D.
March	190		[b] 29.5	1,810	C.
April	360	44	160	9,520	B.
May	450	74	238	14,600	B.
June	320	2	154	9,160	C.
July	182		[b] 9.3	572	D.
August			[a] 2.0	123	D.
Sept. 1-24			[a] 2.0	95	D.
The period				36,800	
1907.					
June 7-30	260	46	139	6,620	C.
July	750	.5	45.7	2,810	C.
August	1,280	.5	123	7,560	C.
September	246	1	38.7	2,300	C.
October			[a] .5	31	D.
November			[a] .5	30	D.
December			[a] .6	37	D.
The period				19.400	
1908.					
January			[a] 0.60	37	D.
February	600	.5	49.7	2,860	C.
March	106	.5	27.1	1,670	B.
April	85	.9	22.1	1,320	B.
May	12.4		3.17	195	C.
June	1.5		.14	8	D.
July	247		12.9	793	D.
August	2,300		154	9,470	D.
December	5.5		1.33	82	B.
The period				16,400	
1909.					
January	27	.9	5.35	329	B.
February	27	.9	6.38	354	A.
March	890	52	158	9,720	A.
April	970	67	278	16,500	B.
May	570	85	222	13,600	A.
June	498	7	161	9,580	A.
July	6	.5	1.53	94	C.
August	920	.5	93.7	5,760	C.
September	[a] 5,000	23	336	20,000	C.
October	23	3	9.6	590	C.
November	3		1.36	81	C.
December	2.5	.1	.49	30	D.
The year	[a] 5,000			76,600	

[a] Estimated. [b] Partly estimated.

NOTE.—The monthly estimates for 1905 to 1908 were obtained from daily discharges found by using the 1909 rating curve as standard for shifting channels from May 25, 1905 to Apr. 10, 1908, and by using it direct from Apr. 11 to Dec. 31, 1908. The low-water discharges are liable to large percentages of error because of infrequent measurements and excessively low flow. It was necessary to make flat estimates for many of the low-water periods. The recorded maximum values are only roughly approximate as the high-water stages were not covered by discharge measurements.

LITTLE COLORADO RIVER BASIN.

DESCRIPTION.

The country drained by Little Colorado River consists of a high plateau with an elevation over 4,000 feet above sea level, extending from the Continental Divide in northwestern New Mexico westward to the San Francisco Mountains in Arizona and from the Grand Canyon of the Colorado southward to the Mogollon Mesa. The greater part of this plateau is composed of rolling plains with a few feet of soil at the surface underlain by rock. Through this plateau the river winds northwestward to its junction with the great Colorado.

The run-off from approximately 6,000 square miles of the drainage area finds its way into the Little Colorado above the mouth of Rio Puerco, the largest tributary, which joins the main stream 2 miles above the town of Holbrook, Ariz. Both the Little Colorado and Rio Puerco are flashy streams, seldom clear even during low stages. Their bottoms are shifting and sandy, and where not confined in canyons the stream beds are wide with abrupt earth banks. The discharge fluctuates greatly, being insignificant in dry seasons. The floods are short and violent and carry large quantities of silt in suspension.

LITTLE COLORADO RIVER AT ST. JOHNS, ARIZ.

This station, which was established April 18, 1906, to determine the amount of water available for irrigation, is located at the south end of the town of St. Johns, half a mile above the dam and county bridge. The bed of the stream is clean, sandy, and shifting. Frequent measurements are necessary to properly determine the daily flow at this station. The discharge measurements and daily gage heights were furnished by the United States Reclamation Service, who maintain this station. The daily and monthly estimates of discharge were made by engineers of the United States Geological Survey.

Discharge measurements of Little Colorado River at St. Johns, Ariz., in 1909.

[By W. D. Rencher.]

Date.	Area of section.	Gage height.	Discharge.	Date.	Area of section.	Gage height.	Discharge.
	Sq. ft.	*Feet.*	*Sec.-ft.*		*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 22	20	0.97	36	July 5	20	0.30	33
29	21	1.00	43	15	16	.20	22
Feb. 8	16	.90	26	22	114	3.00	601
15	16	.90	27	Aug. 2	50	1.30	150
23	16	.89	24	10	38	.90	74
Mar. 1	14	.90	21	16	197	5.80	1,640
10	26	1.00	41	26	38	.57	87
17	26	[a] 1.09	48	Sept. 6	88	1.90	525
26	26	[a] 1.03	45	13	48	.80	139
Apr. 8	25	1.02	43	20	25	.56	53
16	42	1.60	140	28	24	.50	44
24	36	1.20	124	Oct. 8	20	.60	35
May 1	68	.70	181	18	18	.65	29
9	46	.50	107	28	17	.64	27
17	32	.37	64	Nov. 10	18	.65	27
29	22	.23	32	24	18	.66	27
June 9	14	.17	14	Dec. 8	14	.85	27
19	8.0	.13	9.3	19	18	1.00	33
26	8.8	.10	8.2	31	17	1.15	36

[a] Gage height doubtful.

Daily gage height, in feet, of Little Colorado River at St. Johns, Ariz., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.85	0.98	0.90	1.01	0.65	0.20	0.09	0.95	0.90	0.54	0.65	0.78
2	.85	.96	.90	1.02	.60	.20	.10	1.18	1.12	.54	.65	.81
3	.85	.95	.86	1.03	.58	.18	.13	.97	.92	.55	.65	.82
4	.86	.94	.85	1.03	.58	.18	.28	.91	.75	.56	.65	.84
5	.86	.93	.88	1.03	.55	.18	.31	1.10	1.40	.57	.65	.84
6	.86	.90	.90	1.02	.55	.17	.22	1.00	1.85	.58	.65	.85
7	.88	......	.94	1.02	.50	.17	.20	.90	2.12	.60	.65	.86
8	.87	......	.98	1.02	.50	.17	.22	.82	1.95	.60	.66	.86
9	.88	......	.99	1.01	.52	.17	.21	.98	1.08	.62	.66	.86
10	.90	......	1.00	1.02	.50	.16	.20	.95	.92	.62	.65	.85
11	.90	......	1.00	1.03	.50	.16	.20	.82	.90	.63	.65	.88
12	.91	......	1.00	1.03	.47	.16	.20	.75	.86	.64	.64	.94
13	.91	......	1.01	1.03	.45	.15	.20	.72	.80	.64	.64	.93
14	.92	.90	1.02	1.35	.44	.15	.24	.90	.75	.65	.65	.96
15	.94	.90	1.02	1.51	.40	.15	.20	1.75	.68	.65	.65	.95
16	.95	.88	1.03	1.72	.40	.14	.20	3.58	.66	.65	.65	.97
17	.95	.88	1.03	2.05	.38	.14	.28	2.15	.62	.65	.66	.98
18	.95	.90	1.03	1.68	.35	.14	.28	2.45	.60	.65	.66	1.00
19	.95	.90	1.03	1.65	.35	.14	.30	1.90	.58	.65	.66	1.00
20	.95	.90	1.01	1.58	.35	.13	.55	1.45	.56	.66	.66	1.01
21	.94	.89	1.01	1.45	.33	.13	.75	1.60	.55	.66	.66	1.06
22	.97	.88	1.02	1.30	.32	.12	2.60	1.20	.54	.66	.66	1.04
23	.96	.92	1.02	1.25	.31	.12	1.08	.95	.52	.65	.66	1.05
24	.95	.90	1.02	1.20	.30	.11	.80	.80	.51	.65	.66	1.06
25	.97	.90	1.02	1.04	.28	.10	.88	.70	.50	.65	.66	1.10
26	.98	.91	1.03	.85	.26	.10	.85	.56	.50	.65	.67	1.11
27	1.00	.92	1.03	.80	.25	.10	.80	.50	.50	.64	.68	1.12
28	1.00	.92	1.03	.77	.24	.10	.78	.52	.50	.64	.71	1.13
29	1.00	......	1.03	.68	.23	.10	.55	.55	.50	.64	.74	1.14
30	1.00	......	1.02	.69	.22	.10	.42	.54	.50	.64	.77	1.15
31	1.00	......	1.01	......	.20	......	.55	.50	......	.64	......	1.15

Daily discharge, in second-feet, of Little Colorado River at St. Johns, Ariz., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	25	40	21	44	170	26	16	85	200	43	27	29
2	25	36	21	43	155	25	10	126	260	42	28	30
3	25	35	20	44	146	25	16	88	222	40	28	30
4	26	35	20	44	143	23	28	78	192	39	28	30
5	26	34	25	44	133	21	34	111	370	38	28	30
6	26	30	26	43	130	19	26	94	510	37	28	29
7	28	28	30	43	115	17	24	77	574	36	28	28
8	27	26	38	43	110	16	25	65	508	35	29	28
9	28	26	39	43	110	14	24	90	250	35	29	28
10	29	26	41	43	105	12	23	85	200	35	30	26
11	29	26	40	47	103	10	23	65	185	35	30	28
12	30	27	40	47	95	10	22	56	164	34	29	35
13	30	27	41	47	90	10	22	52	139	34	29	32
14	30	27	41	94	85	10	25	77	124	30	29	34
15	34	27	42	121	75	10	22	247	105	30	29	32
16	35	25	43	172	73	9	20	798	94	30	28	32
17	35	25	43	240	68	9	24	365	80	29	28	33
18	35	27	43	170	60	9	20	460	71	29	28	33
19	35	27	43	173	60	9	18	315	62	29	28	33
20	35	27	40	168	60	9	40	212	53	29	27	32
21	34	26	41	150	54	9	60	258	53	29	27	37
22	36	25	42	128	52	8	480	175	52	29	27	35
23	35	28	42	125	50	8	108	133	48	28	27	34
24	33	25	43	124	45	8	63	112	47	28	27	34
25	35	24	43	115	43	8	75	102	45	28	26	38
26	39	24	45	100	40	8	70	85	45	28	25	35
27	40	24	45	115	37	8	63	85	44	27	25	37
28	42	23	45	128	33	8	60	93	44	27	25	38
29	43	......	45	135	32	9	33	105	42	27	28	36
30	42	......	45	158	31	10	20	112	40	27	28	36
31	42	......	44	......	27	......	33	112	......	27	......	36

NOTE.—These discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Little Colorado River at St. Johns, Ariz., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	43	25	32.7	2,010	B.
February	40	23	27.9	1,550	B.
March	45	20	38.0	2,340	B.
April	240	43	99.7	5,930	B.
May	170	27	81.6	5,020	C.
June	26	8	12.6	750	C.
July	480	10	49.1	3,020	C.
August	798	52	159	9,780	C.
September	574	40	161	9,580	B.
October	43	27	32.1	1,970	B.
November	30	25	27.8	1,650	B.
December	38	26	32.5	2,000	B.
The year	798	8	62.9	45,600	

LITTLE COLORADO RIVER AT WOODRUFF, ARIZ.

This station, which was established March 16, 1905, was located about 300 feet below the crossing of the Holbrook-Winslow wagon road and one-fourth mile below the Woodruff dam. It is maintained by the United States Reclamation Service.

The station equipment, which was carried away by the flood of November 26 and 27, 1905, was replaced March 24, 1906. The object of the station was to determine the amount of water available for irrigation. The bed of the stream is sandy and shifting, and frequent measurements are required to determine the daily flow.

No measurements were made in 1909 and only a few gage heights were recorded. The water surface was below the gage during the greater part of January.

LITTLE COLORADO RIVER AT HOLBROOK, ARIZ.

This station, which was established March 17, 1905, to determine the amount of water available for irrigation, is located at the county bridge across Little Colorado River at Holbrook, Ariz.

The bed of the stream is sandy and shifting, and frequent discharge measurements are required to properly determine the daily flow.

No discharge measurements were made in 1909.

This station is maintained by the United States Reclamation Service.

Daily gage height, in feet, of Little Colorado River at Holbrook, Ariz., for 1909.

[Anna Conner, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.4	3.0	3.0	3.0	3.4	2.4	2.6	3.0	5.0	3.6	2.8	3.0
2	3.4	3.0	3.0	3.0	3.3	2.4	2.6	3.0	5.0	3.6	2.8	3.0
3	3.4	3.0	3.0	3.0	3.0	2.4	2.55	4.5	5.2	3.5	2.8	3.0
4	3.4	3.0	3.0	3.0	3.0	2.4	2.5	3.0	5.2	3.4	2.8	3.0
5	3.3	3.0	3.0	3.0	3.0	2.4	2.4	5.5	7.5	3.4	2.8	3.0
6	3.2	3.0	3.0	3.0	3.0	2.4	2.3	5.0	7.0	3.35	2.8	3.0
7	3.2	3.0	3.0	3.0	3.0	2.4	2.2	6.0	5.5	3.3	2.8	3.0
8	3.1	3.0	3.0	3.0	3.0	2.35	2.1	6.0	5.0	3.3	2.8	2.95
9	3.0	3.0	3.0	3.0	3.0	2.3	2.05	6.0	4.9	3.25	2.8	2.9
10	3.0	3.0	3.0	3.0	3.0	2.3	2.0	4.5	4.7	3.2	2.8	2.9
11	3.0	3.0	3.0	3.5	3.0	2.3	2.0	5.8	4.6	3.2	2.8	3.0
12	3.0	3.0	2.9	3.2	2.0	2.3	2.0	6.3	4.55	3.2	2.8	3.0
13	3.0	3.0	2.8	3.0	2.95	2.3	2.0	6.0	4.5	3.1	2.8	3.0
14	3.0	3.0	2.8	3.0	2.9	2.3	2.0	7.8	4.45	3.1	2.8	3.0
15	3.0	3.0	2.8	3.0	2.9	2.25	2.0	6.0	4.4	3.1	2.8	3.0
16	3.0	2.9	2.8	3.0	2.9	2.2	2.0	6.5	4.4	3.1	2.8	3.0
17	3.0	2.8	2.9	3.0	2.9	2.2	2.0	5.0	4.35	3.0	2.8	3.0
18	3.0	2.8	3.0	3.0	2.85	2.1	2.0	7.0	4.3	3.0	2.8	3.0
19	3.0	2.8	3.0	3.0	2.8	2.0	2.0	7.0	4.3	3.0	2.8	4.0
20	3.55	2.8	3.0	3.0	2.8	2.0	2.0	7.5	4.2	3.0	2.8	3.5
21	3.5	2.8	3.0	3.3	2.8	2.0	3.5	7.5	4.1	3.0	2.8	3.0
22	3.4	2.8	3.0	3.5	2.8	2.0	3.5	7.0	4.1	3.0	3.25	3.0
23	3.2	2.8	3.0	3.2	2.8	2.0	3.0	7.5	4.0	2.95	3.15	3.0
24	3.0	2.8	3.0	3.0	2.8	2.0	3.0	7.45	4.0	2.9	3.0	3.0
25	3.0	3.0	3.0	3.0	2.7	2.0	5.5	7.5	4.0	2.9	3.0	2.9
26	3.0	3.0	3.0	3.0	2.6	2.0	4.5	7.8	4.0	2.9	3.0	2.8
27	3.0	3.0	3.0	3.0	2.6	2.8	3.5	7.8	3.9	2.85	3.0	2.9
28	3.0	3.0	3.0	3.0	2.6	2.8	3.0	7.8	3.9	2.8	3.0	3.0
29	3.0	....	3.0	3.0	2.6	2.6	3.0	7.5	3.7	2.8	3.0	3.0
30	3.0	....	3.0	3.4	2.6	2.6	3.0	6.5	3.8	2.8	3.0	3.0
31	3.0	....	3.0	....	2.6	....	3.0	5.5	....	2.8	....	3.0

EVAPORATION AT HOLBROOK, ARIZ.

Observations of evaporation at Holbrook, Ariz., were begun on August 2, 1905, and observations were made daily from that time until December 31, 1909, when they were discontinued.

As water in the river was insufficient to float an evaporation pan during the greater part of the summer months, a cement tank 8 feet square and 3 feet deep was built on the property of Mr. John Conner in the town of Holbrook. In this tank a regulation pan, 3 feet square and 18 inches deep, was floated, so secured as to keep it at all times practically in the very center of the tank. The tank was situated about 25 feet from the house and 50 feet from some large cottonwood trees.

A regulation Weather Bureau rain gage was located in the immediate vicinity and at such distance as to receive the least possible influence from such obstructions as houses and fences.

The prevailing winds in this section are from the southwest to the northeast; the nearest trees on the southwest are about 150 feet away. The trees within 50 feet, above referred to, are practically due north of the site of the tank and exert very little influence on the observations.

The method used in making measurements was as follows: The pan was kept filled within a few inches of the top, the water in the tank outside being kept practically at the same level, the pan being filled to a height indicated by the pointed tip of a vertical rod in the center of the tank. Every morning and evening, after such change as might be brought about by evaporation or rainfall, water level was restored to the original height, the precise amount of water transferred being measured with a cup of such size that one cupful of water was equivalent to 0.01 inch in depth in the tank.

No interruptions occurred in the observations during the year 1905. During 1906 water in the pan froze on January 5 and remained so until January 30, no observations being taken during that period. During the remainder of the year very few interruptions occurred, so that for 1906 the records are fairly complete. The same is true for 1907, 1908, and 1909.

The records show considerable variation between a daily minimum of zero in cold weather and 0.5 inch in hot weather, the maximum figures being occasioned chiefly by days of excessively high wind, which prevails along the Little Colorado for a large part of the spring months.

The tables given below show the monthly evaporation, rainfall, average temperature of water in the pan and average temperature of air. The temperature of water outside the pan did not vary from the temperature of that inside by more than about 1 degree. The records of rainfall and air temperature were obtained from Weather Bureau reports for the station at Holbrook, and may not show precisely the conditions at the evaporation station. The other records were compiled from data furnished by the United States Reclamation Service.

The latitude of Holbrook is about 34.5° north; its longitude about 110° west; its elevation above sea level, 5,072 feet; the rainfall for the period from 1887 to 1908 shows a mean of 8.99 inches, the lowest being 4.58 inches in 1899 and the highest 17.63 inches in 1905.

Monthly evaporation, rainfall, and temperature at Holbrook, Ariz., for 1905–1909.

Month.	Evaporation.	Rainfall.	Temperature.		Month.	Evaporation.	Rainfall.	Temperature.	
			Water in pan.	Air.				Water in pan.	Air.
1905.	*Inches.*	*Inches.*	°*F.*	°*F.*	1906.	*Inches.*	*Inches.*	°*F.*	°*F.*
January	......	......	......	......	January	[b]0.03	1.12	32.5	41.8
February	......	......	......	......	February	1.24	.23	41.9	38.6
March	......	......	......	......	March	3.28	.46	46.4	42.2
April	......	......	......	......	April	5.12	.50	52.2	50.4
May	......	......	......	......	May	6.93	.17	60.3	57.7
June	......	......	......	......	June	8.61	.00	65.6	69.6
July	......	......	......	......	July	7.42	1.11	70.5	76.4
August	[a]6.60	0.76	73.5	76.5	August	6.24	1.25	70.4	74.8
September	4.57	1.37	66.4	68.2	September	5.12	.34	65.3	65.6
October	4.26	.05	56.9	53.6	October	3.44	T.	56.0	55.0
November	1.45	3.82	48.4	44.2	November	[c]1.47	1.22	46.1	43.5
December	.22	1.11	37.5	25.9	December	[d].94	2.32	42.4	31.0

[a] 30 days. [b] 5 days. [c] 26 days. [d] 24 days.

Monthly evaporation, rainfall, and temperature at Holbrook, Ariz., for 1905–1909—Con.

Month.	Evaporation.	Rainfall.	Temperature.		Month.	Evaporation.	Rainfall.	Temperature.	
			Water in pan.	Air.				Water in pan.	Air.
1907.	*Inches.*	*Inches.*	°*F.*	°*F.*	1908.	*Inches.*	*Inches.*	°*F.*	°*F.*
January	[a]0.72	1.64	41.5	38.8	August	5.18	2.71	52.4	74.4
February	[b]1.16	.44	42.4	44.6	September	4.07	.26	49.4	67.4
March	2.28	.71	44.6	48.8	October	3.53	1.31	46.5	52.0
April	3.82	.85	50.9	56.6	November	3.23	.21	44.0	47.0
May	3.98	.73	56.5	57.8	December	3.29	1.51	41.1	39.0
June	3.92	.54	52.0	66.2					
July	6.35	3.09	69.3	76.5	The year	48.62	12.54	45.4	54.7
August	6.39	1.89	71.7	73.2					
September	4.62	.43	66.8	66.8	1909.				
October	3.95	3.44	65.6	56.6	January	4.13	.44	42.6	41.8
November	[c]2.51	1.40	51.2	42.8	February	3.33	.17	42.2	38.6
December	2.37	T.	44.5	37.9	March	1.99	.35	41.5	42.2
					April	2.78	.67	40.7	50.4
1908.					May	4.26	.00	44.1	57.7
January	3.41	.67	44.3	37.0	June	6.79	.02	62.5	69.6
February	3.40	1.49	43.1	39.2	July	7.77	3.99	76.7	76.4
March	2.85	.52	41.4	47.2	August	4.10	2.70	71.9	74.8
April	2.85	.81	42.9	52.4	September	[c]3.63	.31	71.4	65.6
May	4.87	.66	46.3	55.8	October	3.11	.00	65.0	55.0
June	5.18	.24	48.0	68.0	November	2.12	.15	48.8	43.5
July	6.76	2.15	53.4	77.0	December	1.37	1.27	40.7	31.0

[a] 24 days. [b] 27 days. [c] 29 days.

CLEAR CREEK NEAR WINSLOW, ARIZ.

This station, which was established June 13, 1906, to determine the quantity of water available for irrigation, is located 6 miles from Winslow and 3 miles above the Clear Creek Irrigation Co.'s dam and the county bridge. It is one-half mile above the pump house. The bed of the stream is strewn with large bowlders and is permanent.

No discharge measurements were made in 1909.

The station is maintained, and the data have been furnished by the United States Reclamation Service.

Daily gage height, in feet, of Clear Creek near Winslow, Ariz., for 1909.

Day.	Jan.	Day.	Jan.	Day.	Jan.
1	2.1	11	2.1	21	4.0
2	2.1	12	2.1	22	4.0
3	2.1	13	2.1	23	4.0
4	2.1	14	2.1	24	4.0
5	2.1	15	2.1	25	4.0
6	2.1	16	4.1	26	6.5
7	2.1	17	5.0	27	5.5
8	2.1	18	4.25	28	5.0
9	2.1	19	4.0	29	4.5
10	2.1	20	4.0	30	4.0
				31	4.0

NOTE.—Rise on Jan. 16 and 26 due to rain and melting snow in mountains. The stream was flowing more than usual at this season.

FLOOD ON ZUNI RIVER, ARIZ., SEPTEMBER 6, 1909.[1]

During the last 10 days of the month of July, all of August, and the first six days of September, 1909, the rains on the drainage basin of Zuni River in Arizona were heavy; but they were not general over the whole tract, being more in the nature of heavy showers, approaching at times what are termed "cloud bursts."

The Weather Bureau stated in its summary for the month of August:

> For the district [No. 9, in which the Zuni drainage basin is situated], as a whole, the month was the wettest since the beginning of the record, and was even more remarkable for the abnormal distribution of the rainfall than for its intensity.

For the entire Little Colorado Basin the average was 1.782 above the normal.

These rains culminated in heavy discharges on both sides of the Zuni Mountains on September 5 and 6. On the afternoon of September 6 the Bluewater dam on the east slopes of this mountain range was destroyed, and within a few minutes of the same time the water undermined the mesa on the south end of the Zuni dam, on the west slopes, partly wrecking the reservoir. (See Pls. VIII and IX.)

Records were kept of the amount of water flowing into the Zuni reservoir by observing gage heights, the capacity of the reservoir at all depths being known. During the period from July 20 to September 6 there was impounded 9,540 acre-feet of water.

The drainage area of this stream above the reservoir is 650 square miles, at elevations ranging from 6,300 feet at the reservoir to 9,200 feet on the tops of the mountains, which form the Continental Divide.

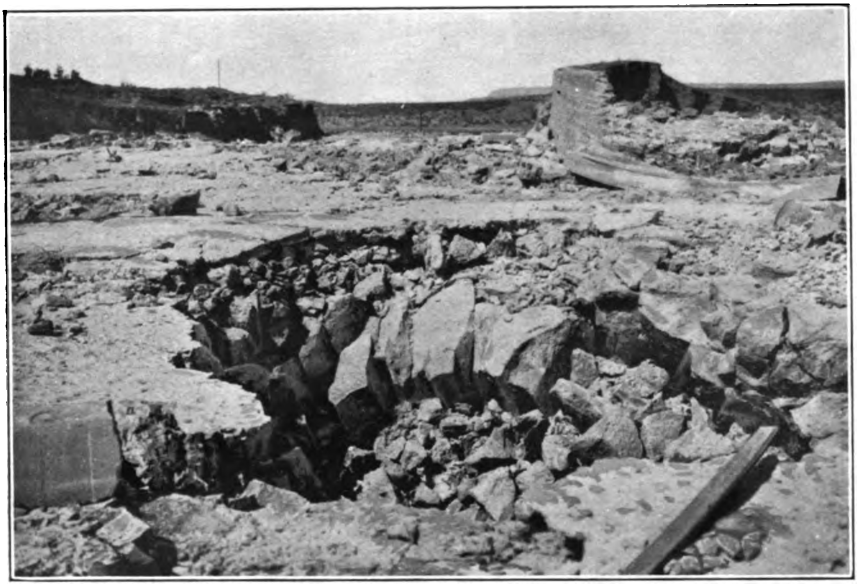
No records of rainfall are available within this drainage area, the nearest one being at Zuni, below the dam site, at Fort Wingate some 35 miles northeast of the dam, and at Manuelito about the same distance northwest, and all at an elevation of about 6,300 feet; the two last mentioned are on other drainage basins. On the east side of the divide records are available from Bluewater station, Bluewater reservoir, and San Rafael. The rainfall on the mountains was undoubtedly heavier than at these lower elevations.

An effort has been made to determine the relation of the run-off to the rainfall by using the available records, but the nature of the country and the peculiar conditions of heavy rains in one section and no precipitation in others a few miles distant make it impossible.

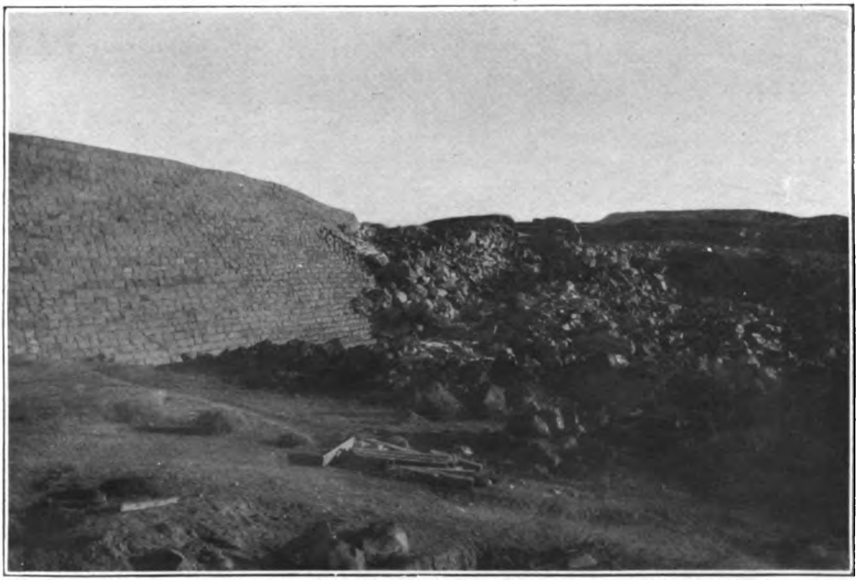
The points where the records were kept on the west of the divide, form a triangle practically 30 miles on a side in an air line, though a

---

[1] By H. F. Robinson, superintendent of irrigation, United States Indian Irrigation Service; published also in Eng. News, vol. 64, Aug. 25, 1910, pp. 203–204.



A. SPILLWAY SURFACE, LOOKING DOWNSTREAM, SHOWING DEPRESSION CAVITY, WRECKED SPILLWAY, AND BOTH WRECKED WALLS.



B. LOWER TOE OF DAM, SHOWING MOVEMENT AND BREAK IN MASONRY AT SPILLWAY.

FAILURE OF ZUNI DAM, N. MEX., SEPTEMBER 6, 1909.

third longer by any road, and there is nothing in the rainfall records to indicate a general storm of similar intensity at any time during the period. On days when rain was recorded at all three points the precipitation varied greatly—as on August 2: Manuelito 1.05, Fort Wingate trace, Blackrock 0.35; or as on the 29th: Manuelito 0.50, Fort Wingate 0.20, Blackrock 0.20; and on September 6: Manuelito

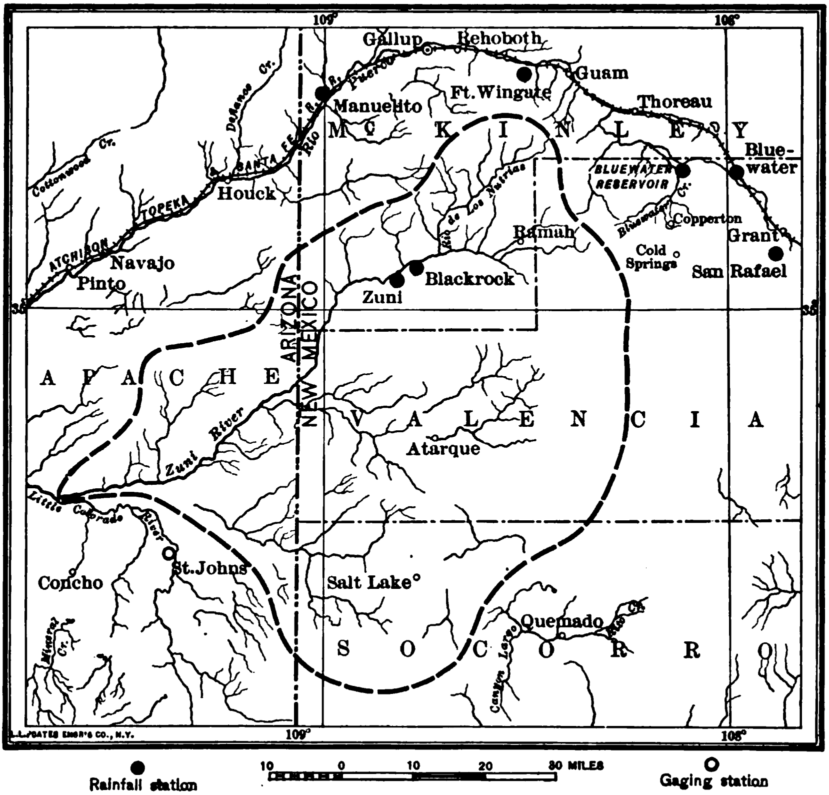


FIGURE 1.—Map of Zuni River drainage basin, showing rainfall stations.

0.01, Fort Wingate 1.20, and Blackrock 0.46. On these same dates, on the east slope of the mountains the record shows:

August 2, Bluewater, 0.0; Bluewater reservoir, 0.0; San Rafael, 0.0.
August 29, Bluewater, 0.12; Bluewater reservoir, 0.0; San Rafael, 0.96.
September 6, Bluewater, record lost; Bluewater reservoir, Tr.; San Rafael, 0.70.

The accompanying tables show the rainfall at these six points and the inflow into the Zuni reservoir.

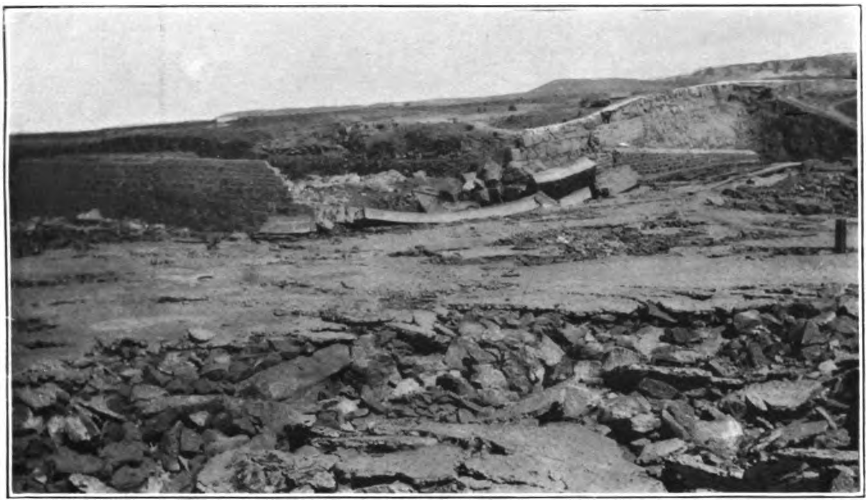
Precipitation, in inches, between July 20 and Sept. 6, 1909.

Date.	Blackrock.	San Rafael.	Bluewater reservoir.	Bluewater station.	Fort Wingate.	Manuelito.	Increase in reservoir in acre-feet.
July 20	0.02			0.24	0.40	0.33	
21	.03	0.14			.10	.20	
22	.04		0.35		Tr.	.10	
23	.05	1.38		.47	.40		1,160
24	.07	.06			.10	.70	
25	.20			.05	.40		
26	.20	.30					
27			Tr.				
28							
29							
30			Tr.			.01	
31	.20			.15			
Aug. 1		.51	.71	.30	.10	.15	320
2	.35				Tr.	1.05	
3	.29	.29	Tr.	.18			20
4	.35	.82			.20	.10	280
5	.28	.17		.13	.20		440
6					.50	Tr.	380
7	.09		.20		.20	.50	
8					.10	.35	50
9	.13			.27	.20	.20	60
10	.10			.04		.70	
11	.04	1.52	Tr.	.05	Tr.		200
12		1.18	Tr.	.48	Tr.	.20	
13	Tr.						
14	.08	.50	.50				50
15	Tr.				Tr.		
16	Tr.	.74	.32		.50		360
17	.01	.19		.28	.10		80
18	.06	60	.18		.20		180
19	.02	.76	.22	.38	Tr.		820
20	Tr.				.30		100
21		.90	.62	.28	.20		900
22	Tr.		.29			.50	180
23	.63		Tr.	.37	.20	3.00	20
24	.07						780
25	Tr.		Tr.	.37	1.30		80
26	Tr.	.44	Tr.	.58	.50		
27	Tr.		.03		.20		20
28	Tr.	.45	Tr.		Tr.		
29	.13	.96		.12	.20	.50	
30	.20			.63	.20	.30	
31			.66				
Sept. 1	.03	.18	Tr.		.40	.50	
2							260
3	.04	.38	.63		.32		
4	.20		.91		1.20	.50	
5	.60	.88	.42		.59	.20	540
6	.46	.70	Tr.		1.20	.01	[a] 2,260
Total for period, July 20 to Sept. 6	4.97	14.05	6.04	5.00	10.51	10.10	

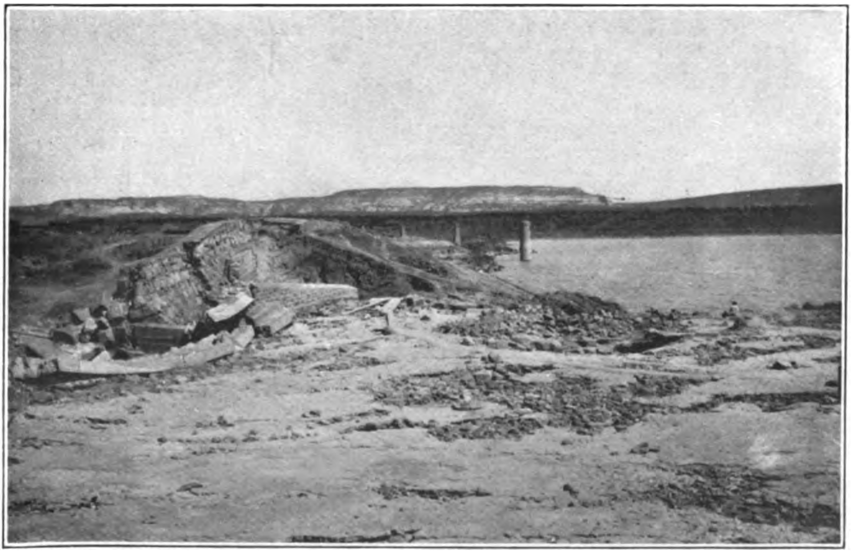
[a] To 4 p. m. when Zuni reservoir failed. Bluewater dam went out at practically the same time.

The rains began about July 20, and there had been no flow in Zuni River for some time previous to this date. A heavy rain was recorded at Fort Wingate on the 20th, and on the night of the 22d and the day of the 23d the amount of water impounded was 1,160 acre-feet.

The small value of existing rainfall records in this connection is shown by the reports for the 25th and 26th; these days 0.2 inch of rain was recorded at the fort, but there was no flow into the reservoir. No further rainfall was recorded until August 1, but on that day there was an increase of water in the reservoir of 320 acre-feet, showing a local rain in the drainage area.



A. VIEW OF SPILLWAY, LOOKING NORTHEAST.



B. VIEW OF INTAKE, LOOKING NORTHEAST.

FAILURE OF ZUNI DAM, N. MEX., SEPTEMBER 6, 1909.

No relation between the precipitation at these stations and the run-off is apparent, but probably some relation could be discovered were records available for a period of years.

The following table shows day by day the amount stored in the reservoir and gives the average run-off for the day, but no records were kept that will show the actual flood and its fluctuations:

Log of the Zuni reservoir, July 22 to Sept. 6, 1909.

Data.	Gage height (feet).	Total (acre-feet).	Gain (acre-feet).	Notes.
July 22	28.0	5,300	....	First rains.
23	30.7	6,460	1,160	
Aug. 1	31.4	6,780	320	
3	31.5	6,800	20	
4	32.1	7,080	280	
5	33.1	7,520	440	
6	33.8	7,900	380	
8	33.9	7,950	50	
9	34.1	8,010	60	Discharge through dam, 34 gallons a minute.
11	34.5	8,210	200	
14	34.6	8,260	50	
16	35.3	8,620	360	
17	35.5	8,700	80	Discharge, 40 gallons.
18	35.8	8,880	180	
19	37.5	9,700	820	Discharge clear, 66 gallons.
20	37.7	9,800	100	Discharge, 96 gallons a. m., 54 gallons p. m.
21	39.4	10,700	900	Discharge muddy, 138 gallons.
22	39.7	10,880	180	Muddy a. m., clear p. m., 66 gallons.
23	39.8	10,900	20	First noticed small crack on top of dam. Discharge, 66 gallons.
24	41.25	11,680	780	Muddy, discharge, 87 gallons.
25	41.4	11,760	80	Clear, discharge, 96 gallons. Slip on hillside of 5 or 6 feet, more cracks developed above tunnel.
26	....	....	....	Discharge, 96 gallons.
27	41.8	11,780	20	Discharge in morning, 87 gallons; 1 p. m. sink at north end and 15 feet of parapet wall fell out, discharge, 284 gallons, then fell to 187 gallons.
28	....	....	....	Discharge, 150 gallons, hole about 30 feet in diameter and 4 to 5 feet deep; 5 p. m. discharge, 96 gallons; 11 p. m. discharge, 96 gallons.
29	....	....	....	Discharge same. Slips at old quarry go deeper. Slide at tunnel mouth. Tunnel discharge, 96 gallons; had been 20.
30	....	....	....	Discharge, 134 gallons.
31	....	....	....	Discharge, 134 to 165 gallons.
Sept. 1	....	....	....	Discharge, 154 gallons.
2	41.9	12,040	260	Discharge, 114 gallons.
3	....	....	....	Discharge, 96 gallons.
5	42.9	12,580	540	Discharge, 124 gallons.
6, a. m.	45.6	14,020	1,440	Discharge, 467 gallons.
noon	46.6	14,560	540	Discharge, about same.
4 p. m.	47.1	14,840	280	Several second-feet. Failure of Zuni reservoir began about 4 p. m. Bluewater dam went out at practically the same time.

On September 5, following several days of rain in the mountains, the run-off measured 540 acre-feet. Between dark that day and daylight the next morning the run-off was 1,440 acre-feet; by noon there was 540 additional feet accounted for, and between noon and 4 p. m., when the mesa failed, 280 acre-feet more, or a total of 2,260 acre-feet in about 21 hours.

This so-called failure of the Zuni dam has thus been described by James D. Schuyler, consulting engineer:

The extraordinary rupture and subsidence of the mesa adjacent to the Zuni dam on the south side, as the result of leakage through the basaltic cap rock, occurred September 6, 1909, after the reservoir had filled almost to overflowing, producing a complete wreck of the spillway, with its fine masonry side walls, and within a week had permitted to escape about one-half the contents of the reservoir. This accident has attracted widespread attention among engineers, as it is quite without precedent in the annals of hydraulic engineering. The foundations of dams sometimes give way underneath the superimposed structures, but it is quite a novel experience that a dam and its foundations should remain intact while the adjacent territory forming its abutment at highest level should prove so unstable as to sink from 4 to 9 feet and leak to the extent of 5,000 cubic feet per second around the end of the dam, when it had appeared to be particularly sound, solid, and water tight.

A fairly complete report of this failure was given in the Engineering News for December 2, 1909.

VIRGIN RIVER BASIN.

DESCRIPTION.[1]

Virgin River rises in the Colob Plateau, in the southwestern part of Utah, at an altitude ranging from 8,000 to 10,000 feet above sea level, flows in a general southerly course across the southwestern corner of Arizona into Nevada, where it turns and flows southward to its junction with the Colorado at Rioville, just above Boulder Canyon. The smaller creeks that drain the eastern portion of the plateau unite after descending to an altitude of 5,500 feet above the sea and form what is called the Parunuweap Fork of the Virgin. At and below the junction of these creeks the canyon valley in which they flow widens into what is known as Long Valley. Below Long Valley the East Fork enters Parunuweap Canyon and is simply a series of cascades for 15 miles, descending in this distance from 5,000 to 3,500 feet above sea level. Emerging from this canyon, it enters the valley of the Virgin. This valley is 44 miles long. Its upper portion is only an enlargement of the canyon; its lower portion is a broader valley, much broken by low basalt-covered mesas and sharp ridges of tilted sedimentary rocks. In the upper portion of the valley the river receives several tributaries, the principal ones being Little Zion, North Fork, La Verkin, and Ashe creeks. Midway of the valley two streams enter that come from Pine Valley Mountains, and near the foot Santa Clara River joins the Virgin, the united streams leaving the valley by a deep canyon cut through the Beaver Dam Mountains. The valley of the Virgin is at a lower altitude and has a warmer climate than any other portion of Utah. The soil of the irrigable lands is usually good, and wherever irrigation can be practiced it produces abundant crops.

VIRGIN RIVER AT VIRGIN, UTAH.

This station, which was established April 18, 1909, is located about half a mile east of and above the town of Virgin, Utah.

---

[1] Abstracted from report on the lands of the arid region of the United States, with a more detailed account of the lands of Utah, by J. W. Powell, 1878: Chapter 9, Irrigable lands of that portion of Utah drained by the Colorado River and its tributaries, by A. H. Thompson, pp. 151-153.

The station is about 1,000 feet below North Creek and is above Ashe and La Verkin creeks, which enter about 8 miles below. There are no diversions of any importance above.

The records are unaffected by ice or by artificial control above or below the station. The bed of the stream changes to a great extent during floods.

The first gage was used until August 7 when the section was changed by a flood causing the water to leave the gage. On August 31 the gage, cable, and bench marks were washed out and the section materially altered. On October 13 a new gage was installed at a different datum. Owing to the marked change in the channel, there can be no determined relation between the old and new gages.

Discharge measurements of Virgin River at Virgin, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 30	E. A. Porter	89	139	2.65	457
July 13	do	84	64.1	1.65	88
23	Walter Spencer	90	151	2.8	557
Oct. 13[a]	E. A. Porter	56	56.1	[b]2.8	163

[a] Made after the change in channel conditions. [b] Gage height from new gage at different datum.

Daily gage height, in feet, of Virgin River at Virgin, Utah, for 1909.

[M. A. Hamilton, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.	Dec.
1		4.0	2.6	1.3	1.5		2.95	2.8
2		3.8	2.6	1.3	1.6		2.9	2.9
3		3.8	2.6	1.2	1.7		2.8	2.9
4		3.8	2.6	1.3	1.6		2.75	3.1
5		3.6	2.7	1.3	1.5		2.9	3.0
6		3.4	2.7	1.4	1.5		2.85	2.8
7		3.4	2.6	1.4			3.0	2.7
8		3.7	2.6	1.5			3.0	2.8
9		3.5	2.5	1.6			2.95	2.9
10		3.4	2.5	1.6			2.9	2.7
11		3.4	2.5	1.7			3.0	2.9
12		3.2	2.4	1.7			3.1	2.8
13		3.2	2.4	1.7		2.8	3.1	2.8
14		3.3	2.4	1.7		2.85	3.4	2.8
15		3.1	2.4	1.7		2.75	3.3	2.85
16		3.1	2.4	1.7		2.8	3.35	2.8
17		3.0	2.4	1.7		2.65	3.1	2.7
18	3.2	3.0	2.4	1.7		2.7	3.0	2.6
19	3.5	3.0	2.3	1.7		3.2	2.95	
20	3.9	3.0	2.3	1.7		2.65	3.1	
21	3.7	2.9	2.1	1.9		2.8	3.0	
22	3.3	2.9	2.1	2.1		2.7	2.9	2.6
23	3.0	2.9	2.1	2.8		2.75	2.95	2.7
24	3.2	2.8	2.0	2.3		2.8	2.8	2.7
25	3.0	2.8	2.0			2.85	2.8	2.6
26	3.2	2.8	2.0			2.9	2.9	2.6
27	4.4	2.7	1.9			2.75	2.85	2.8
28	4.4	2.7	1.7			2.9	2.8	2.7
29	4.9	2.7	1.7			2.8	2.85	2.9
30	4.6	2.6	1.6			2.95	2.75	3.1
31		2.6				3.0		5.1

NOTE.—On Oct. 13 new gage established and gage heights beginning this date are not comparable with those obtained earlier in the year.

Daily discharge, in second-feet, of Virgin River at Virgin, Utah, for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.	Dec.
1	....	1,550	440	24	58	....	222	173
2	....	1,340	440	24	78	....	205	205
3	....	1,340	440	10	101	....	173	205
4	....	1,340	440	24	78	....	158	278
5	....	1,140	495	24	58	....	205	240
6	....	965	495	40	40	....	189	173
7	....	965	440	40	58	....	240	144
8	....	1,240	440	58	....	....	240	173
9	....	1,050	390	78	....	....	222	205
10	....	965	390	78	....	....	205	144
11	....	965	390	101	....	....	240	205
12	....	810	340	101	....	....	278	173
13	....	810	340	101	....	173	278	173
14	....	885	340	101	....	189	418	173
15	....	740	340	101	....	158	368	189
16	....	740	340	101	....	173	393	173
17	....	675	340	101	....	131	278	144
18	810	675	340	101	....	144	240	118
19	1,050	675	295	101	....	321	222	118
20	1,440	675	295	101	....	131	278	118
21	1,240	610	218	155	....	173	240	118
22	885	610	218	218	....	144	205	118
23	675	610	218	550	....	158	222	144
24	810	550	185	295	....	173	173	144
25	675	550	185	265	....	189	173	118
26	810	550	185	235	....	205	205	118
27	2,010	495	155	205	....	158	189	173
28	2,010	495	101	175	....	205	173	144
29	2,580	495	101	146	....	173	189	205
30	2,260	440	78	117	....	222	158	278
31	....	440	....	188	....	240	....	1,930

NOTE.—These discharges are based on rating curves applicable as follows: Apr. 18 to Aug. 7, fairly well defined below 600 second-feet; Oct. 13 to Dec. 31, not well defined.

Monthly discharge of Virgin River at Virgin, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
Apr. 18-30	2,580	675	1,330	34,300	C.
May	1,550	440	819	50,400	C.
June	440	78	314	18,700	B.
July	550	24	128	7,870	B.
Aug. 1-7	101	40	67.3	934	B.
Oct. 13-31	321	131	182	6,860	B.
November	418	158	233	13,900	B.
December	1,930	118	226	13,900	C.

SANTA CLARA RIVER NEAR CENTRAL, UTAH.

This station, which was established April 21, 1909, is located about 1½ miles southeast of Central, Utah, the nearest post office, and about 6 miles west from the settlement of Pine Valley, Utah. It is about one-fourth mile from R. H. Hunt's ranch house in a small valley known as Eightmile Flat. The records show the total amount of water available for storage in the Pine Valley reservoir site, a few miles above the station.

The station is below all important tributaries except Mountain Meadows Creek, which enters about 10 miles below. A small canal whose maximum capacity is about 3.5 second-feet takes out water a short distance above the station.

The gage heights are not affected by ice. The bed of the stream is somewhat shifting, but fairly accurate results have been obtained. The datum of the staff gage on the left bank has remained unchanged since the station was established. Discharge measurements are made from a gaging bridge.

Discharge measurements of Santa Clara River near Central, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 21[a]	E. A. Porter	....	....	3.80	102
June 1[b]	.....do	30	38	3.60	60
July 15	.....do	20	20	3.12	15
Oct. 6	.....do	20	29	3.60	39
16	.....do	23	30	3.50	30

[a] Made one-fourth mile above gage. Results not good.

[b] Made by wading.

Daily gage height, in feet, of Santa Clara River near Central, Utah, for 1909.

[Royal Hunt, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	4.0	3.7	3.25	3.1	7.0	3.6	3.4	3.6
2	....	3.9	3.8	3.25	3.1	4.4	3.6	3.45	3.6
3	....	4.0	3.7	3.6	3.1	4.0	3.7	3.4	3.55
4	....	4.1	3.8	3.4	3.1	4.0	3.7	3.35	3.5
5	....	4.1	3.8	3.3	3.0	4.0	3.6	3.35	3.5
6	....	4.2	3.8	3.3	3.0	4.0	3.6	3.35	3.5
7	....	4.2	3.8	3.3	3.1	3.9	3.6	3.35	3.5
8	....	4.2	3.7	3.3	3.1	3.8	3.6	3.35	3.5
9	....	4.2	3.6	3.25	3.1	3.7	3.6	3.4	3.7
10	....	4.2	3.6	3.25	3.1	3.6	3.6	3.4	3.7
11	....	4.0	3.5	3.2	3.1	3.6	3.55	3.4	3.6
12	....	4.0	3.5	3.2	3.0	3.6	3.55	3.4	3.5
13	....	3.8	3.4	3.2	3.05	3.55	3.5	3.4	3.5
14	....	3.7	3.4	3.1	3.0	3.55	3.5	3.4	3.45
15	....	3.7	3.4	3.1	3.0	3.5	3.5	3.4	3.45
16	....	3.8	3.4	3.1	3.2	3.5	3.55	3.4	3.45
17	....	3.7	3.4	3.1	3.3	3.5	3.5	3.4	3.4
18	....	3.7	3.4	3.1	3.3	3.5	3.5	3.4	3.4
19	....	3.7	3.3	3.1	3.3	3.4	3.5	3.4	3.4
20	....	3.7	3.3	3.1	3.3	3.4	3.45	3.4	3.45
21	3.8	3.8	3.3	3.1	3.3	3.4	3.45	3.45	3.45
22	3.7	3.8	3.2	3.0	3.3	3.4	3.45	3.45	3.5
23	3.7	3.7	3.2	3.1	3.2	3.4	3.45	3.45	3.5
24	3.6	3.6	3.2	3.1	3.2	3.4	3.45	3.45	3.4
25	3.6	3.6	3.2	3.1	3.2	3.4	3.45	3.45	3.4
26	3.7	3.7	3.2	3.1	3.15	3.3	3.45	3.5	3.4
27	3.9	3.7	3.1	3.1	3.2	3.7	3.45	3.5	3.4
28	4.1	3.6	3.1	3.1	3.2	4.0	3.45	3.55	3.4
29	4.2	3.7	3.2	3.1	3.3	3.8	3.45	3.55	3.4
30	3.8	3.7	3.2	3.1	3.3	3.7	3.45	3.55	3.4
31	....	3.7	....	3.1	3.6	....	3.4	....	6.5

Daily discharge, in second-feet, of Santa Clara River near Central, Utah, for 1909.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	117	69	27	15	475	37	27	37
2	....	106	77	27	15	100	37	30	37
3	....	117	69	46	15	64	43	27	34
4	....	124	75	32	15	64	43	25	32
5	....	124	75	27	12	64	37	25	32
6	....	136	75	27	12	64	37	25	32
7	....	136	75	27	15	56	37	25	32
8	....	136	66	27	15	49	37	25	32
9	....	132	56	23	15	43	37	27	43
10	....	132	56	23	15	37	37	27	43
11	....	110	50	21	15	37	34	27	37
12	....	110	50	21	12	37	34	27	32
13	....	90	44	21	14	34	32	27	32
14	....	77	41	15	12	34	32	27	30
15	....	77	41	15	12	32	32	27	30
16	....	86	41	15	19	32	34	27	30
17	....	77	41	15	23	32	32	27	27
18	....	77	41	15	23	32	32	27	27
19	....	74	34	15	23	27	32	27	27
20	....	74	34	15	23	27	30	27	30
21	102	84	34	15	23	27	30	30	30
22	92	84	29	12	23	27	30	30	32
23	92	74	29	15	19	27	30	30	32
24	79	63	26	15	19	27	30	30	27
25	79	63	26	15	19	27	30	30	27
26	89	72	26	15	17	23	30	32	27
27	109	72	22	15	19	43	30	32	27
28	132	63	22	15	19	64	30	34	27
29	140	69	24	15	23	49	30	34	27
30	96	69	24	15	23	43	30	34	27
31	....	69	....	15	37	....	27	....	393

NOTE.—These discharges are based on rating curves applicable as follows: Apr. 21 to July 15, indirect method for shifting channels used; July 15 to Dec. 31, fairly well defined below 50 second-feet, not well defined above.

Monthly discharge of Santa Clara River near Central, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
Apr. 21-30	140	79	101	2,000	B.
May	136	63	93.4	5,740	B.
June	77	22	45.7	2,720	C.
July	46	12	19.9	1,220	C.
August	37	12	18.1	1,110	C.
September	475	23	56.6	3,370	C.
October	43	27	33.3	2,050	B.
November	34	25	28.3	1,680	B.
December	393	27	43	2,640	B.
The period	....	....	....	22,500	

SANTA CLARA RIVER NEAR ST. GEORGE, UTAH.

This station, which was established April 16, 1909, to determine the total unappropriated discharge of Santa Clara River, is located about 3 miles southwest of St. George, Utah, and about 2 miles above the mouth of the river.

The station is below all tributaries and diversions except two canals which head near the mouth of the river.

The gage heights are not affected by ice, but the bed of the stream shifts to a considerable extent. A fair record of run-off has, however, been obtained for 1909. The datum of the sloping gage on the left bank has remained unchanged since the station was established. The gage is underneath a footbridge from which the discharge measurements are made.

Discharge measurements of Santa Clara River near St. George, Utah, in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 27	E. A. Porter	18.5	13	2.02	35
31	.....do	20	14	2.10	45
July 14	.....do	5	1.2	1.35	(a)
Oct. 8	.....do	25.5	9.5	2.62	33
15	.....do	18	7.6	2.30	20

a Estimated eight-tenths second-foot.

Daily gage height, in feet, of Santa Clara River near St. George, Utah, for 1909.

[E. A. Everett, observer.]

Day.	Apr.	May.	June.	July.	Sept.	Oct.	Nov.	Dec.
1		2.5	2.1		10.0	2.0	1.9	
2		2.4	2.1		4.0	2.0	1.9	
3		2.4	2.2		2.0	2.5	1.8	2.5
4		2.5	2.2		1.5	2.6	1.8	2.4
5		2.6	2.3			2.6		2.4
6		2.7			4.0	2.6	1.8	2.4
7		2.8	2.3		5.0	2.7		2.4
8		2.8	2.3		1.5	2.6		2.4
9			2.2		1.5	2.6	2.5	2.9
10		2.8	2.1		1.5		2.7	2.7
11		2.7	1.8		1.5	2.6	2.3	
12		2.5	1.7		1.5	2.5	2.2	
13		2.4	(a)		1.5	2.3	2.2	2.5
14		2.4		1.35	1.5	2.3		
15		2.4			1.5	2.3	2.4	2.4
16	3.0	2.4			1.5	2.3		
17	3.2	2.4			1.0			
18		2.3			1.0	2.2	2.2	2.3
19		2.3			1.0	2.1	2.2	
20	2.6	2.3			1.0	2.1	2.2	2.4
21	2.6	2.3			1.0			2.4
22	2.5	2.4			1.0	2.1	2.3	2.4
23	2.3				1.0	2.0	2.3	2.5
24	2.2	2.3			1.0			2.5
25		2.2			3.0	2.0	2.3	
26	2.4	2.1			4.0	2.0		
27	2.3	2.1			2.0	2.0	2.7	2.5
28	2.4	2.1			2.0	2.0		2.4
29	2.4	2.4			1.7	2.0	2.5	2.4
30	2.3				1.7		2.5	2.4
31		2.1						3.6

a See page 216.

NOTE.—Gage heights for September are unreliable.

Daily discharge, in second-feet, of Santa Clara River near St. George, Utah, for 1909.

Day.	Apr.	May.	June.	Oct.	Nov.	Dec.	Day.	Apr.	May.	June.	Oct.	Nov.	Dec.
1	......	79	42	3	1	28	16	145	69	.5	17	18	20
2	......	69	42	3	1	28	17	179	69	.5	14	15	18
3	......	69	50	28	......	28	18	150	59	.5	12	12	17
4	......	79	50	35	......	22	19	120	59	.5	7	12	20
5	......	90	59	35	......	22	20	90	59	.5	7	12	22
6	......	102	59	35	......	22	21	90	59	.5	7	14	22
7	......	115	59	43	9	22	22	79	69	.5	7	17	22
8	......	115	59	35	18	22	23	59	64	.5	3	17	28
9	......	115	50	35	28	61	24	50	59	.5	3	17	28
10	......	115	42	35	43	43	25	60	50	.5	3	17	28
11	......	102	20	35	17	38	26	69	42	.5	3	30	28
12	......	79	15	28	12	33	27	59	42	.5	3	43	28
13	......	69	.5	17	12	28	28	69	42	.5	3	36	22
14	......	69	.5	17	17	25	29	69	69	.5	3	28	22
15	......	69	.5	17	22	22	30	59	56	.5	3	28	22
							31	......	42	......	2	......	153

NOTE.—These discharges are based on rating curves applicable as follows: Apr. 16 to Aug. 31, fairly well defined below 60 second-feet; Sept. 1 to Dec. 31, not well defined; June 13 to Aug. 31, discharge due to seepage only and has been estimated.

Gage heights unreliable for September; no estimates made.

From June 13 to Aug. 31 the flow was due to seepage only.

Monthly discharge of Santa Clara River near St. George, Utah, for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
Apr. 16-30	179	50	89.8	2,670	B.
May	115	42	72.4	4,450	A.
June	....	....	[a] 18.5	1,100	B.
July	....	....	[a] .5	31	C.
August	....	....	[a] .5	31	C.
October	43	2	16.1	990	B.
November	43	....	16.5	982	B.
December	153	17	30.5	1,880	B.

[a] From June 13 to Aug. 31 the flow was due to seepage only. Discharge for this period estimated on basis of measurement made July 14.

MUDDY RIVER NEAR MOAPA, NEV.

This station, which is located at the Narrows, about 7 miles from Moapa, Nev., the nearest railway point, was established January 1, 1904, to determine the amount of water available for storage in a reservoir site at this point.

No gage heights are available since 1906, but occasional measurements have been made since that time. Discharge measurements for 1909 were made in a flume which carries the entire flow of the river except during floods.

Measurements made in 1908 at the station were published in Water-Supply Paper 249, page 197, under "miscellaneous measurements in Virgin River drainage basin."

Discharge measurements of Muddy River near Moapa, Nev., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec. ft.*
Jan. 4	E. C. La Rue	8	13.4	1.67	48
4	.....do	8	14.8	1.85	55
4	.....do	8	11.8	1.47	38
19	U. V. Perkins	8	12.4	1.55	40
Mar. 17	A. L. F. McDermott	8	4.0	.60	5.1
Apr. 27	U. V. Perkins	8	10.4	1.30	46
May 14	.....do	8	8.4	1.05	32
June 1	.....do	8	4.7	.59	9.3
1	.....do	8	6.4	.80	18
1	.....do	8	7.4	.92	24
1	.....do	8	8.8	1.10	35
July 2	E. C. La Rue	8	2.9	.34	22
2	.....do	8	8.7	1.05	30
2	.....do	8	6.6	.80	15
2	.....do	8	10.0	1.22	37
2	.....do	8	4.2	.50	6.3
Nov. 27	.....do	8	12.0	1.45	43

GILA RIVER BASIN.

DESCRIPTION.

Gila River rises in western and southwestern New Mexico, receiving its waters from mountains having an elevation of 7,000 to 8,000 feet. At the point where it crosses into Arizona it still has an elevation of 6,000 feet. From this place it flows between mountain ranges and falls rapidly, until at Florence, 180 miles away, it is about 1,500 feet above sea level. At a point about 15 miles above Florence the river emerges upon the plains, through which it winds for about 75 miles before receiving the waters of its principal tributary, the Salt. From the junction of the Salt the Gila continues west and southwest and enters the Colorado at Yuma, Ariz, near the southwest corner of the Territory.

The principal tributaries are San Pedro and Santa Cruz rivers from the south, and San Francisco, Salt,[1] Agua Fria, and Hassayampa rivers from the north.

San Francisco River rises in the southwestern part of Socorro County, N. Mex., and flows southwestward into Graham County, Ariz., where it unites with the Gila. The basin comprises about 2,600 square miles, of which 1,800 square miles are in New Mexico and 800 in Arizona.

San Pedro River rises in the northern part of the Mexican State of Sonora, flows northward for more than 100 miles, and empties into the Gila a few miles below the town of Dudleyville, 45 miles above Florence, Ariz. Rising in a country of very light snowfall, the river depends for the greater part of its water supply on the frequent showers of the rainy seasons. It flows over a sandy bed between high, steep banks, and during the dry season it shrinks to an insignificant stream of clear water, which rises and sinks in the sand with the varying depth of bed rock.

---

[1] For description of Salt River, see p. 227.

The floods of the upper Gila and its tributaries are commonly short and violent, occurring during the months of January and February. A period of high water occurs also usually during the late summer or early fall. The season of low water occurs in June and July.

The drainage basin of the Gila includes 7,000 square miles of merchantable timberland, 11,000 square miles of woodland, of which the San Francisco basin has 1,000 square miles of timberland, 45,000 square miles of land upon which there is no timber, 1,300 square miles of scattered timber, and 300 square miles of open land.

The average annual precipitation over the greater part of the contributary drainage area of Gila and San Francisco rivers in New Mexico is between 10 and 15 inches and in the high mountains of the headwater region it rises above 20 inches.

The winters are mild except in the mountainous sections, and very little ice forms on the rivers.

Irrigation in New Mexico has been confined chiefly to the bottom lands along the main streams and their tributaries, but the total area irrigated comprises only a very few thousand acres. Excellent opportunities for irrigation exist along both the Gila and the San Francisco. The United States Reclamation Service has made surveys for an irrigation project in the vicinity of Alma, N. Mex. Another promising district is that popularly known as the Lordsburg flat, which extends from Lordsburg, N. Mex., northward to Gila River, a distance of over 20 miles, and comprises over a quarter of a million acres of almost unbroken and very fertile land, at an elevation a little above 4,000 feet. This land could be irrigated by the stored water of Gila River, although the expense of reaching it would be considerable.

Good storage sites exist at various places along San Francisco and Gila rivers, among which may be mentioned the reservoir site on the San Francisco near Alma, and that on the Gila near Redrock, N. Mex.

Because of the torrential character of the Gila, water-power development is not feasible except where stored water is used. The San Francisco, being more of a mountain stream, presents better opportunities for the use of water power along its upper reaches. Most of the future water-power development along these streams will probably be in connection with irrigation projects. At present it is limited to one or two small plants on the San Francisco.

GILA RIVER NEAR REDROCK, N. MEX.

This station was originally established May 14, 1908, at the mouth of the Middle Box Canyon of the Gila (Pl. V, *B*), about 2 miles east of Redrock post office, N. Mex. On July 16, 1909, it was moved about one-eighth mile upstream in the canyon. The two nearest railroad points are Silver City, about 36 miles east of Redrock, and Lordsburg, about 30 miles south.

The records show the amount of water available for irrigation and power enterprises.

Mancos River, an intermittent stream, the first large tributary upstream from the station, joins the Gila about 12 miles above. A number of large washes come into the river above and below the station, and during flood stages the run-off from these tributaries is very great. The drainage area at the station is about 3,500 square miles A number of large irrigation ditches divert water above the station. Practically no power is developed in the headwaters of this basin, although opportunity for such development is good.

Except for fringe ice along the edges of the stream, ice does not interfere with the accuracy of the results.

The gage originally installed May 14, 1908, is bolted to a rock bluff on the left bank just a few feet above the mouth of the canyon. This gage was abandoned July 16, 1909, when a Friez automatic gage was installed on the left bank about one-eighth mile upstream and at a different datum. An auxiliary staff gage, which is necessary as a guide in setting the automatic gage, was not installed until August 18.

The accuracy of the base data obtained at this station is impaired by the adverse natural conditions. The station is isolated and the stream bed very shifting in character. Measurements by wading are more or less affected by quicksand.

Discharge measurements of Gila River near Redrock, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.		Discharge.
				Automatic gage.	Staff gage.	
		Feet.	*Sq. ft.*	*Feet.*	*Feet.*	*Sec. ft.*
Feb. 1	J. B. Stewart	82.5	107	....	1.39	244
Mar. 1	.....do	107	145	....	1.40	318
June 14	.....do	57	42	....	1.00	97
July 11	.....do	63	44	....	.82	67
13	.....do	32.5	24	....	.67	42
16	.....do	51.5	41	1.75	.95	85
Aug. 18	.....do	154	142	2.80	1.65	398
Sept. 3	.....do	41	51	2.20	.91	132
Oct. 14	W. B. Freeman	47.5	62	1.43	....	92

NOTE.—All measurements made by wading at various sections.

Daily gage height, in feet, of Gila River near Redrock, N. Mex., for 1909.

[J. G. Rutland and A. B. Conner, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.75	1.4	1.2	1.6	1.35	1.1	......	......	2.35	1.45	1.4	1.5
2	.75	1.2	1.6	1.6	1.3	1.1	......	......	2.25	1.4	1.4	1.6
3	.7	1.0	1.6	1.5	1.3	1.1	......	......	2.25	1.5	1.4	1.7
4	.7	.8	1.6	1.5	1.2	1.0	......	......	2.3	1.5	1.4	1.65
5	.7	1.1	1.55	1.4	1.2	1.0	......	......	2.8	1.5	1.4	1.65
6	.7	1.0	1.7	1.2	1.3	1.0	......	......	4.9	1.45	1.4	1.65
7	.65	.95	1.6	1.2	1.2	.8	......	......	3.2	1.45	1.4	1.65
8	.65	1.3	1.6	1.3	1.2	.8	......	......	2.8	1.45	1.4	1.65
9	.65	1.0	1.6	1.4	1.2	.6	......	......	2.75	1.4	1.45	1.65
10	.6	1.6	1.8	1.4	1.2	.6	......	......	2.7	1.4	1.45	1.7
11	1.1	1.4	1.9	1.5	1.2	.6	0.8	......	3.3	1.4	1.45	1.5
12	.9	1.3	1.9	1.8	1.2	.7	......	......	3.4	1.4	1.45	1.5
13	.75	1.2	2.4	2.0	1.2	.8	.65	......	3.1	1.4	1.5	1.55
14	.7	1.0	2.6	1.6	1.2	.95	......	3.3	3.0	1.4	1.5	1.55
15	.7	1.0	1.9	1.5	1.3	.4	.65	3.6	2.9	1.4	1.5	1.55
16	.65	1.4	1.9	1.5	1.3	.4	.95	2.9	2.8	1.4	1.5	1.55
17	.8	1.3	2.2	1.4	1.3	.4	......	3.0	2.7	1.4	1.5	1.6
18	.8	1.2	2.0	1.4	1.3	.3	......	2.85	2.6	1.4	1.5	1.7
19	.7	1.6	1.9	1.3	1.2	.3	......	2.75	......	1.4	1.5	1.7
20	.7	1.4	2.4	1.3	1.2	.3	......	2.65	......	1.45	1.45	1.7
21	.95	1.4	2.2	1.6	1.3	.3	......	2.5	......	1.45	1.45	1.7
22	.85	1.2	1.9	1.6	1.3	.3	......	2.5	......	1.4	1.5	1.8
23	.8	1.1	2.1	1.5	1.3	.3	......	2.35	......	1.5	1.5	1.8
24	.8	1.0	2.0	1.4	1.2	.3	......	2.4	......	1.5	1.5	1.85
25	.75	1.2	1.9	1.4	1.2	.3	......	2.3	1.6	1.5	1.5	2.0
26	.7	1.3	2.3	1.3	1.2	.3	......	2.25	1.55	1.55	1.5	......
27	.7	1.2	2.3	1.3	1.2	.3	......	2.15	1.5	1.55	1.55	......
28	.7	1.2	2.3	1.3	1.2	.4	......	2.8	1.5	1.55	1.55	......
29	.9	......	2.0	1.3	1.2	.4	......	2.3	1.5	1.55	1.5	......
30	.8	......	2.4	1.4	1.2	......	......	2.2	1.45	1.4	1.5	......
31	.7	......	2.6	......	1.2	......	......	2.3	......	1.4	......	......

Daily discharge, in second-feet, of Gila River near Redrock, N. Mex., for 1908–9.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1908.			1908.			1908.		
1	......	80	11	......	51	21	53	52
2	......	70	12	......	76	22	53	52
3	......	58	13	......	67	23	106	43
4	......	58	14	......	67	24	80	43
5	......	50	15	......	49	25	74	83
6	......	97	16	105	49	26	65	55
7	......	90	17	96	83	27	395	47
8	......	80	18	75	64	28	330	48
9	......	62	19	75	52	29	132	40
10	......	54	20	66	52	30	80	42
						31	......	42

Daily discharge, in second-feet, of Gila River near Redrock, N. Mex., for 1908-9.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1909.												
1	47	248	174	415	288	142	25	185	173	72	90	108
2	47	160	390	415	253	142	30	185	147	68	90	116
3	42	98	390	360	253	142	30	185	143	78	90	181
4	42	59	395	360	205	100	35	185	158	90	90	123
5	42	126	365	299	205	100	35	220	280	90	90	123
6	42	98	462	195	253	100	40	210	1,120	84	90	123
7	37	86	395	195	205	60	45	210	410	84	90	123
8	37	203	395	243	205	60	50	260	278	84	90	123
9	37	98	395	299	205	36	55	320	282	86	95	123
10	33	370	536	299	205	36	60	370	268	86	95	181
11	116	250	610	360	205	36	65	420	470	86	95	103
12	70	210	610	565	205	46	52	470	505	88	95	103
13	47	166	1,030	730	193	58	40	530	395	88	103	109
14	42	102	1,210	435	193	85	40	590	378	90	103	109
15	42	102	620	370	240	24	40	710	345	90	103	109
16	38	258	620	370	240	24	85	435	312	90	103	109
17	56	210	860	308	240	24	58	473	284	90	103	116
18	56	166	698	308	240	16	105	416	255	90	103	181
19	44	380	620	250	193	16	233	375	230	90	103	181
20	44	258	1,040	250	193	16	220	333	205	95	95	181
21	84	258	860	435	240	16	220	280	180	95	95	181
22	65	174	620	435	240	16	220	273	155	90	103	149
23	56	137	775	376	240	16	220	226	125	103	103	149
24	56	107	707	313	178	16	220	232	100	103	103	159
25	49	174	629	313	178	16	233	202	82	103	103	193
26	44	217	962	255	178	16	233	284	75	109	103	190
27	44	174	962	255	178	16	220	158	72	109	109	190
28	44	174	962	255	178	24	185	315	72	109	109	190
29	74	....	708	255	178	24	185	180	78	109	103	190
30	56	....	1,050	313	178	24	185	152	72	90	103	190
31	44	....	1,230	....	178	....	185	167	....	90	......	190

NOTE.—These discharges for 1908-9 were obtained by the indirect method for shifting channels. Discharges estimated for days for which no gage heights are given.

Monthly discharge of Gila River near Redrock, N. Mex., for 1908-9.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1908.					
Nov. 16-30	395	53	119	3,540	B.
December	97	40	59.9	3,680	B.
1909.					
January	116	33	50.9	3,130	B.
February	380	59	181	10,100	B.
March	1,230	174	686	42,200	B.
April	730	195	341	20,300	B.
May	288	178	212	13,000	B.
June	142	16	48.2	2,870	C.
July	233	25	118	7,260	D.
August	710	152	308	18,900	D.
September	1,120	72	255	15,200	D.
October	109	68	91.3	5,610	D.
November	109	90	98.3	5,850	D.
December	193	103	148	9,100	D.
The year	1,230	16	211	154,000	

NOTE.—Prior to Nov. 16, 1908, the data are too meager or unreliable on which to base estimates.

SAN FRANCISCO RIVER AT ALMA, N. MEX.

This station, which was established October 18, 1904, by the United States Reclamation Service, is located about half a mile southeast of Alma, N. Mex., and 85 miles northwest of Silver City, the most accessible railway point. It was discontinued by the Reclamation Service December 31, 1907, and was reestablished by the United States Geological Survey on January 1, 1909.

The station is a short distance below the mouth of Mineral Creek and about 5 miles above the mouth of Whitewater Creek. The waters of the San Francisco and its tributaries are used to some extent for mining and a few small ditches take out water above the station for irrigation of the bottom lands. The flow of this stream is very little affected by ice, though thin ice sometimes forms on the edges.

The rod gage established January 1, 1909, is at a different location and datum from those of the previous gage. It was washed out on September 6, 1909, and replaced October 10, 1909, by another sloping-rod gage 100 feet upstream at the same datum. Gage heights during the interval that the gages were out were read from a temporary gage installed by the observer and later reduced to the new gage datum. High-water measurements have been made from a cable 300 feet upstream from the location of the last gage.

Very good measurements can be obtained at this station, but they should be made frequently in order to obtain the best results, as the stream bed is shifting in character.

Discharge measurements of San Francisco River at Alma, N. Mex., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 2	J. B. Stewart	38	19.6	0.74	37
Feb. 7	.....do	39	19.0	1.00	52.0
Apr. 21	.....do	61	60.0	1.55	214.0
June 6	.....do	25	7.0	.45	8.7
6	.....do	19	5.8	.45	8.5
July 4	.....do	25.5	8.0	.58	15.9
Aug. 7	.....do	32.5	13.2	.65	28.0
Oct. 10	W. B. Freeman	29.5	12.5	.75	15.8

Daily gage height, in feet, of San Francisco River at Alma, N. Mex., for 1909.

[Cora Jackson and Minnie Bowers. observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.7	1.0	1.2	2.0	1.0	0.5	0.3	0.6	0.6	1.0	0.5	0.95
2	.7	1.0	1.0	2.0	1.0	.5	.3	.6	.6	.9	.6	.85
3	.7	1.0	1.5	2.0	1.0	.5	.3	1.0	.9	.8	.5	.85
4	.7	1.0	2.0	2.5	1.0	.5	.5	.5	1.0	.8	.5	.85
5	.7	1.0	2.2	2.5	1.0	.5	.45	1.35	2.9	.8	.6	.95
6	.7	1.0	1.9	2.0	1.0	.45	.7	.7	1.0	.8	.6	.95
7	.7	1.0	2.0	2.0	1.0	.45	.5	1.0	1.0	.8	.6	1.0
8	.7	1.5	1.8	2.0	.85	.4	.5	1.0	1.0	.8	.55	1.0
9	.7	1.0	1.5	2.0	.85	.4	.5	1.2	1.0	.8	.55	1.0
10	.75	1.0	1.5	1.7	.85	.4	.5	2.2	.9	.75	.55	1.0
11	.75	1.0	1.5	1.7	.7	.4	.2	1.0	.9	.7	.6	.95
12	.75	1.0	1.4	1.7	.7	.4	.2	1.4	.9	.65	.6	.95
13	.8	1.8	1.2	1.7	.7	.4	.3	1.3	.8	.6	.6	.95
14	.8	1.5	1.2	1.7	.7	.4	.2	1.8	.8	.6	.7	.95
15	.8	1.5	1.5	1.7	.7	.4	.2	1.2	.8	.6	.7	.95
16	.8	1.3	1.5	1.7	.7	.4	.6	1.2	.8	.55	.7	.95
17	.8	1.3	2.3	2.0	.7	.4	.4	1.0	.8	.7	.7	.95
18	.8	1.0	3.0	1.7	.7	.4	1.2	1.3	.8	.65	.75	.95
19	.8	1.0	2.5	1.7	.7	.4	.6	.9	....	.6	.75	.95
20	.8	1.0	2.1	2.0	.7	.4	3.0	.8	....	.6	.75	.95
21	.8	1.0	2.2	1.6	.7	.35	.6	.8	....	.6	.7	.95
22	.8	1.0	2.0	1.4	.6	.35	.6	1.1	....	.5	.7	.95
23	.8	1.0	2.0	1.4	.6	.3	.6	.8	....	.5	.7	.95
24	.8	1.0	2.0	1.3	.6	.3	.8	1.1	....	.5	.7	.95
25	.8	1.0	1.6	1.15	.5	.3	.8	.7	....	.6	.75	.95
26	.8	1.1	1.8	1.1	.5	.3	1.0	.6	....	.7	.75	.95
27	2.0	1.1	2.0	1.1	.5	.3	.6	.5	....	.5	.7	.95
28	2.75	1.2	2.0	1.0	.5	.3	.6	.5	....	.4	.7	.95
29	2.0	....	2.0	1.0	.5	.3	.5	.5	....	.5	.8	.95
30	1.5	....	2.0	1.0	.5	.3	.6	.6	....	.5	.95	.95
31	1.0	....	2.0	....	.5	....	1.0	.6	....	.5	....	.95

NOTE.—Gage heights for 1909 are not referred to the same datum as that used by the United States Reclamation Service in 1907.

Daily discharge, in second-feet, of San Francisco River at Alma, N. Mex., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	33	52	88	485	52	11	4	24	16	39	6	30
2	33	52	52	485	52	11	4	24	16	29	9	22
3	33	52	192	485	52	11	4	72	40	20	6	22
4	33	52	490	840	52	11	11	17	52	20	6	22
5	33	52	620	840	52	11	9	182	1,140	20	9	30
6	31	52	420	485	52	9	23	32	52	18	9	30
7	31	52	485	485	52	9	11	72	52	18	9	34
8	31	192	355	485	35	7	11	70	52	18	7	34
9	31	52	192	485	35	7	12	118	48	18	7	34
10	36	52	192	295	35	7	12	690	36	16	7	34
11	34	52	192	295	23	7	3	70	36	13	9	30
12	34	52	148	295	23	7	3	194	36	11	9	30
13	39	355	88	295	23	7	6	143	28	9	9	30
14	39	192	88	295	23	7	3	410	28	9	13	30
15	39	192	192	295	23	7	3	116	28	9	13	30
16	37	114	192	295	23	7	19	105	28	7	13	30
17	37	114	690	485	23	7	10	62	26	13	13	30
18	37	52	1,200	295	23	7	249	137	26	11	16	30
19	37	52	840	295	23	7	20	48	30	9	16	30
20	37	52	550	485	23	7	1,200	37	30	9	16	30
21	35	52	620	240	23	5.5	22	37	30	9	13	30
22	35	52	485	148	16	5.5	22	80	30	6	13	30
23	35	52	485	148	16	4	22	37	30	6	13	30
24	35	52	485	114	16	4	38	73	30	6	13	30
25	35	52	240	78	11	4	40	25	30	9	16	30
26	33	68	355	68	11	4	68	18	30	13	16	30
27	510	68	485	68	11	4	23	12	30	6	13	30
28	1,050	88	485	52	11	4	23	12	30	3	13	30
29	510	....	485	52	11	4	17	12	30	6	18	30
30	208	....	485	52	11	4	24	18	30	6	30	30
31	56	....	485	....	11	....	70	18	....	6	....	30

NOTE.—These discharges have been obtained by the indirect method for shifting channels.

Monthly discharge of San Francisco River at Alma, N. Mex., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	1,050	31	104	6,400	C.
February	355	52	84.7	4,700	B.
March	1,200	52	399	24,500	C.
April	840	52	324	19,300	B.
May	52	11	27.3	1,680	B.
June	11	4	6.90	411	C.
July	1,200	3	64.1	3,940	C.
August	690	12	95.6	5,880	C.
September	1,140	16	70.0	4,170	D.
October	39	3	12.6	775	D.
November	30	6	12.0	714	D.
December	34	22	29.7	1,830	D.
The year	1,200	3	102	74,300	

SANTA CRUZ RIVER NEAR NOGALES, ARIZ.

This station, which was established March 22, 1907, was located about 5 miles from Nogales, near Yerba Buena ranch. Conditions of flow are subject to change. It was discontinued November 30, 1907, and reestablished April 1, 1909. No discharge measurements were made in 1909.

This station is maintained and the data have been furnished for publication by the United States Reclamation Service.

Daily gage height, in feet, of Santa Cruz River near Nogales, Ariz., for 1909.

[Mr. Harrison, observer.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.8	3.4	2.9	2.65	3.8	3.4	3.3	3.2	3.4
2	2.8	2.8	2.9	2.65	3.75	3.4	3.3	3.2	3.4
3	2.8	2.8	2.8	3.92	3.75	3.4	3.3	....	3.4
4	2.85	3.3	2.8	3.25	3.7	3.4	3.3	3.3	3.4
5	2.85	....	2.8	3.22	3.65	3.4	....	3.3	3.4
6	2.8	....	2.8	3.35	3.68	3.4	3.3	3.3	3.4
7	2.7	3.3	2.8	2.8	3.6	3.4	3.3	3.3	3.4
8	2.8	3.3	2.8	2.7	3.9	3.4	....	3.25	3.4
9	2.8	3.3	2.8	2.7	3.8	3.35	3.3	3.2	3.4
10	2.7	3.3	2.8	2.7	3.7	3.3	3.3	....	3.4
11	2.7	3.3	2.75	2.7	3.6	3.3	3.3	3.2	3.4
12	2.8	3.3	2.75	2.7	3.6	3.3	3.3	3.4	3.4
13	2.8	2.9	2.75	2.7	3.95	....	3.3	3.35	3.4
14	2.8	3.2	2.75	2.7	3.6	3.3	3.3	3.35	3.35
15	2.8	3.2	2.75	2.7	3.9	3.3	3.3	3.3	3.35
16	2.8	3.2	2.7	3.3	5.2	....	3.3	3.3	3.35
17	2.8	3.2	2.7	4.02	5.75	3.3	3.3	3.3	3.3
18	....	3.2	2.7	5.3	4.9	3.3	3.3	3.3	3.3
19	2.8	3.2	2.7	3.25	3.9	3.3	3.3	3.3	3.35
20	2.8	3.2	2.7	3.25	3.8	3.3	3.3	3.3	3.3
21	2.8	....	2.7	3.72	3.8	3.3	3.3	3.3	3.3
22	2.75	3.6	2.7	4.58	3.8	3.3	3.3	3.3	3.3
23	2.8	3.6	2.7	3.75	4.4	3.3	3.3	3.3	3.35
24	....	3.6	2.7	3.62	3.7	3.3	3.3	3.3	3.35
25	2.8	3.6	2.7	3.2	3.6	3.3	3.3	3.3	3.35
26	3.4	3.6	2.7	3.08	3.6	3.35	3.3	3.3	3.35
27	3.4	3.5	2.65	3.0	3.6	3.3	3.3	3.35	3.35
28	3.4	3.5	2.65	2.9	3.6	3.3	3.3	3.6	3.4
29	3.4	3.5	2.65	2.9	3.5	3.3	3.3	3.5	3.4
30	3.4	3.0	2.65	2.85	3.4	3.3	3.25	3.4	3.4
31	....	3.0	....	2.82	3.4	....	3.2	....	3.4

SANTA CRUZ RIVER AND DITCHES AT TUCSON, ARIZ.

This station was established October 15, 1905, at Congress Street Bridge, Tucson, Ariz. The gage height records were discontinued November 12, 1907, but discharge measurements have been made since then by engineers of the United States Reclamation Service, who maintain the station.

Manning and Farmers ditches divert practically the entire flow during the low period of Santa Cruz River. These ditches are taken out just above the gaging station, and their flow is determined by current-meter or weir measurements, supplemented by daily records, kept by the ditch managers, of the amount of water contained in each. On April 16 and 17, 1908, a permanent Cippoletti weir was established on Manning ditch 3 miles below the head gate. This water is used to irrigate lands on the north and south sides of Santa Cruz River in and about the vicinity of Tucson.

Conditions of flow are changeable.

The results published herewith were furnished by the United States Reclamation Service.

Discharge measurements of Santa Cruz River at Tucson, Ariz., in 1908–9.

[By engineers of the United States Reclamation Service.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
1908.	*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*	1909.	*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 5	53	53	0.92	213	July 19	46	28	0.22	85
July 28	38	21	.16	61	19	94	274	3.20	....
Aug. 18	42	42	.38	163	19	91	170	2.06	....
Sept. 9	89	172	2.00	1,080	20	36	20	.50	32
9	58	93	1.07	616	23	55	79	.82	372
					24	93	292	3.40	....
1909.					26	84	79	.89	432
Mar. 16	9.0	1.5	....	2.4	Aug. 6	72	36	.23	91
24	6.5	1.4	....	2.3	15	78	89	.90	445
Apr. 5	7.5	6.2	.03	14	16	86	147	2.02	974
July 17	30	27	.14	83	17	82	58	1.10	287

Discharge measurements of Manning ditch near Tucson, Ariz., in 1908–9.

[By engineers of the United States Reclamation Service.]

Date.	Discharge.	Date.	Discharge.
1908.	*Sec.-ft.*	1909.	*Sec.-ft.*
Mar. 2	11.2	Jan. 15	6.2
Apr. 11	9.9	22	8.3
18	7.3	Feb. 19	9.6
21	8.6	Mar. 30	7.6
21	10.2	Apr. 8	9.1
May 9	8.7	May 29	6.1
30	5.3	June 7	5.0
June 1	5.3	11	5.5
21	4.4	17	5.0
July 14	4.3	23	3.9
25	8.2	July 7	5.9
30	11.7	8	4.8
31	10.4	14	3.1
Aug. 8	8.8	14	4.8
11	8.5	15	3.4
25	8.2	Aug. 2	7.1
Sept. 7	11.2	27	6.6
Nov. 3	7.6	Sept. 3	9.5
11	5.5		

NOTE.—1908. Measurements Mar. 2, Apr. 11, 21 (second), 1908, and July 14 (second), 1909, were made by current meter at head gate. All others were made by weirs 3 miles below head gate.

From Feb. 2 to 22, 1908, ditch was dry. Diversion dam washed out 4 p. m. Mar. 22 to noon Mar. 23. Apr. 14 to 18, ditch dry for cleaning. Apr. 16–17, permanent Cippoletti weir established 3 miles below head gate.

Measurement July 25, 30, and 31 contain Farmers ditch water.

1909. Measurement Mar. 30, 1909, made before cleaning ditch; that of Apr. 8 made after cleaning. May 17–18, water developed at head. May 19–22, ditch cleaned. Diversion dam washed out July 4 and again July 6, 1909.

Monthly discharge of Santa Cruz River and ditches at Tucson, Ariz., for 1908–9.

Month.	River discharge in second-feet.			Run-off (total in acre-feet).			Total.
	Maximum.	Minimum.	Mean.	River.	Manning ditch.	Farmers ditch.	
1908.							
January	16	....	2.3	130	600	240	970
February	213	....	30.3	1,750	240	120	2,110
March	19	....	2.1	130	660	380	1,170
April	19	....	1.6	90	420	300	810
May	....	....	....	....	530	300	830
June	....	....	....	....	300	250	500
July	6,780	....	132	8,100	460	....	8,560
August	220	....	37	2,280	225	40	2,540
September	1,080	....	31.5	1,870	430	210	2,510
October	....	....	....	....	490	250	740
November	....	....	....	....	470	240	710
December	25	0.5	12.6	780	180	70	1,030
The year	6,780	....	20.8	15,100	5,000	2,400	22,500
1909.							
January	4	.4	1.9	120	430	280	830
February	4	1.0	2.5	140	540	260	940
March	4	1.0	2.2	130	510	250	890
April	14	....	3.8	230	400	240	870
May	6	....	.8	50	300	200	550
June	....	....	....	....	240	180	420
July	1,740	....	94.0	5,820	120	120	6,060
August	1,610	....	121	7,510	130	....	7,640
September	940	....	21.0	1,260	500	....	1,760
October	....	....	....	200	....	....	....
November	....	....	....	160	....	....	....
December	....	....	....	200	....	....	....
The period	....	....	....	15,800	....	....	....

NOTE.—The river carried water from Manning ditch 12½ days in October, 10 days in November, and 13½ days in December.

SALT RIVER DRAINAGE BASIN.

DESCRIPTION.

Salt River, though considered a tributary of the Gila, is in fact larger both in catchment area and in discharge. It receives the drainage from central Arizona, its principal tributary, the Verde, flowing southeasterly and south from the mountains and tablelands south of Colorado River. The Verde Valley is situated in Yavapai County, Ariz., on the headwaters of the stream, and extends from a canyon above Camp Verde to a point about 10 miles below the fort. About a mile below the junction of the Verde and 30 miles above Phoenix the Salt enters upon the plains of the Gila Valley.

The Salt River project involves the construction of a large storage reservoir controlled by the Roosevelt dam, on Salt River, at Roosevelt, Ariz., about 70 miles northeast of Phoenix, and the Granite Reef dam, on the same stream, about 40 miles below the Roosevelt dam, diverting water into the old Arizona canal on the right side of the river and into the highland canal on the left side of the river; the enlargement of these two canals, and the consolidation of the canal systems in the Salt River valley, in the vicinity of Phoenix and Mesa, Ariz., into two systems receiving water from these two canals. A power plant is being constructed at the storage dam for generating power from stored water in the reservoir and from water diverted from a power canal heading at a diversion dam on the Salt River about 18½ miles above the storage dam. This power will be partly sold for industrial uses and partly used for pumping water from underground sources onto high lands in the Gila Indian reservation and in the Salt River valley. The power canal diversion dam, the power canal, the Roosevelt dam, and the Granite Reef dam are completed; the power plant, the improvements of the Arizona canal system, and the wells for underground pumping are under construction.[1]

SALT RIVER AT McDOWELL, ARIZ.

This station, which was established April 20, 1897, to determine the amount of water available for irrigation, is located one-third mile above the junction of Salt and Verde rivers, 30 miles northeast of Phoenix, 15 miles northeast of Mesa, and 1¾ miles above the Arizona canal diversion dam.

The bed of the river at this point is sandy and shifting, and frequent measurements are required to properly determine the daily discharge.

The station is maintained by the United States Reclamation Service.

---

[1] Description of the Salt River project taken from Seventh Ann. Rept. U. S. Recl. Service, 1907-8, pp. 50-51.

Discharge measurements of Salt River at McDowell, Ariz., in 1909.

[By W. Richins.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 4	2.80	137	July 16	4.15	363
8	2.30	48	20	4.10	333
12[a]	2.20	50	23	4.25	411
18[a]	2.15	[b] 56	26	4.35	511
23[a]	4.25	1,080	28	4.60	732
26[a]	6.30	3,770	30	4.65	746
29[a]	7.65	6,410	Aug. 3	4.50	619
Feb. 2[a]	5.95	4,500	6	4.40	571
5[a]	5.95	3,910	10	4.85	864
11	6.10	3,420	13	4.95	1,030
12	6.25	4,110	17	5.65	1,690
16	6.60	4,080	20	6.00	1,900
19	6.45	3,540	24	5.75	1,660
23	6.60	3,760	27	5.65	1,560
26	5.95	2,680	31	5.40	1,450
Mar. 2	6.55	3,520	Sept. 3	5.20	1,200
5	5.50	[c] 1,800	7	5.40	1,510
9	6.50	3,200	8	8.15	4,790
12	6.00	2,360	10	8.35	6,000
16	6.40	3,320	14	7.45	3,910
19	3.50	[c] 194	17	6.80	2,940
23	6.75	3,350	21	6.05	1,920
26	6.75	3,420	23	5.80	1,660
30	7.15	4,100	24	5.70	1,470
Apr. 2	7.35	4,520	29	5.25	1,060
6	7.40	4,260	Oct. 1	5.15	910
9	7.20	3,720	5	4.85	670
13	4.90	[c] 852	8	4.75	548
16	7.55	4,510	12	4.60	516
20	7.95	5,820	15	4.50	446
23	7.85	5,290	17	4.45	404
27	7.85	5,370	22	4.40	383
30	5.90	[c] 1,870	26	4.30	328
May 4	3.45	118	29	4.30	334
7	6.55	3,120	Nov. 2	4.25	314
7	6.55	3,760	5	4.25	328
8	5.80	[c] 1,710	8	5.20	998
10	3.80	153	9	5.30	1,150
12	3.65	112	10	5.80	1,530
14	3.50	98	11	5.85	1,560
17	3.45	109	12	5.85	1,600
19	3.85	270	16	5.75	1,430
21	4.25	449	17	5.75	1,420
25	4.75	738	19	5.75	1,450
28	4.95	886	23	5.70	1,400
June 1	4.95	884	26	5.65	1,350
4	4.95	887	28	5.50	1,230
8	4.90	732	30	5.50	1,250
11	4.85	719	Dec. 3	5.05	986
15	4.80	720	7	4.50	560
18	4.70	675	9	4.30	457
22	4.60	559	10	3.85	[c] 237
25	4.60	557	14	3.45	95
29	4.50	506	17	3.40	78
July 2	4.40	444	20	3.90	[d] 294
6	4.35	438	23	3.95	322
9	4.35	428	28	3.35	[c] 106
13	4.25	413	31	3.30	108

---

[a] Made by J. C. Leaming.
[b] Gage height affected by backwater in Verde River.
[c] Low discharge is caused by closing gates at Roosevelt dam.
[d] Water turned back in river.

Daily gage height, in feet, of Salt River at McDowell, Ariz., for 1909.

[W. Richins, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.80	6.15	6.70	7.38	4.42	4.95	4.42	4.55	5.32	5.12	4.25	5.28
2	5.45	5.95	6.52	7.32	3.75	4.95	4.40	4.50	5.28	5.08	4.25	5.25
3	3.50	5.85	6.50	4.35	3.58	4.95	4.40	4.48	5.20	5.00	4.25	5.08
4	2.82	5.95	6.65	5.65	3.42	4.92	4.40	4.42	5.15	4.92	4.25	5.05
5	2.65	5.98	6.25	6.90	3.38	4.92	4.35	4.40	5.20	4.85	4.25	4.80
6	2.50	5.92	6.42	7.40	3.35	4.90	4.35	4.40	5.25	4.80	4.20	4.60
7	2.38	5.95	6.40	7.25	6.52	4.90	4.35	4.40	6.02	4.78	4.20	4.52
8	2.30	5.95	6.45	7.20	5.80	4.90	4.35	4.40	8.22	4.72	5.20	4.40
9	2.30	5.85	6.48	7.20	4.00	4.90	4.32	4.78	8.48	4.70	5.32	4.28
10	2.22	6.00	6.05	7.25	3.82	4.88	4.30	4.85	8.30	4.65	5.78	3.98
11	2.20	6.22	6.00	7.40	3.68	4.85	4.30	4.80	8.10	4.60	5.82	3.70
12	2.20	6.38	6.00	7.55	3.62	4.85	4.25	4.80	7.80	4.60	5.85	3.60
13	2.20	6.20	6.15	4.55	3.58	4.85	4.25	4.92	7.58	4.55	5.85	3.50
14	2.20	6.60	6.50	3.75	3.50	4.80	4.20	4.95	7.40	4.52	5.80	3.45
15	3.62	6.60	6.62	7.45	3.45	4.80	4.18	4.95	7.15	4.50	5.80	3.45
16	3.32	6.60	6.42	7.55	3.45	4.78	4.15	5.50	6.95	4.50	5.75	3.42
17	2.30	6.55	6.00	7.80	3.45	4.75	4.10	5.70	6.75	4.45	5.75	3.40
18	2.15	6.40	3.85	4.55	3.65	4.70	4.10	5.92	6.55	4.45	5.45	3.40
19	2.10	6.38	3.70	7.80	3.90	4.70	4.10	6.00	6.35	4.45	5.75	3.40
20	2.10	6.55	6.75	7.92	4.05	4.65	4.10	5.98	6.15	4.40	5.75	3.88
21	2.10	6.50	6.70	7.32	4.28	4.60	4.10	5.92	6.05	4.40	5.75	3.90
22	2.10	6.58	6.70	7.90	4.42	4.60	4.28	5.80	5.98	4.40	5.70	3.95
23	4.30	6.60	6.72	7.85	4.55	4.60	4.25	5.75	5.82	4.35	5.70	3.95
24	5.42	6.38	6.68	7.85	4.62	4.60	4.25	5.72	5.68	4.35	5.70	3.62
25	5.40	5.95	6.78	7.85	4.78	4.58	4.35	5.62	5.58	4.30	5.65	3.40
26	6.32	5.95	6.72	7.85	4.88	4.50	4.38	5.62	5.45	4.30	5.62	3.35
27	4.28	6.00	6.10	7.85	4.95	4.50	4.50	5.62	5.35	4.30	5.70	3.35
28	6.65	6.10	6.20	7.62	4.95	4.50	4.60	5.58	5.30	4.28	5.50	3.35
29	7.55	....	7.20	7.32	5.00	4.48	4.65	5.50	5.22	4.30	5.40	3.35
30	6.90	....	7.18	5.85	4.95	4.45	4.62	5.45	5.12	4.30	5.48	3.35
31	6.55	....	7.40	....	4.95	....	4.60	5.70	....	4.30	....	3.35

NOTE.—Rise Jan. 15–17 due to backwater from Verde River. No change in amount turned out at Roosevelt.

Gage heights are affected by regulation at Roosevelt dam.

Maximum recorded gage heights occurred as follows: Jan. 29, 7.70; Feb. 1, 6.15; May 7, 6.55; Aug. 31, 6.00; Sept. 9, 8.50; Oct. 1, 5.15; and Dec. 1, 5.30 feet.

Minimum recorded gage heights occurred as follows: Mar. 19, 3.50; April 14, 3.70; Sept. 30, 5.10; and Oct. 28, 4.25 feet.

Daily discharge, in second-feet, of Salt River at McDowell, Ariz., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,800	4,700	3,920	4,700	920	944	450	670	1,340	880	320	1,090
2	2,230	4,500	3,480	4,500	200	920	450	630	1,250	840	314	1,060
3	440	4,100	3,450	460	140	900	450	610	1,150	780	320	1,000
4	145	4,000	3,570	1,500	110	870	450	590	1,120	760	325	940
5	120	4,000	1,550	3,100	90	830	450	580	1,200	670	328	790
6	80	3,700	3,280	4,280	70	800	448	571	1,280	620	330	660
7	60	3,600	3,140	3,900	3,100	750	440	560	2,440	590	330	610
8	60	3,500	3,170	3,720	1,710	734	440	560	5,600	530	998	530
9	60	3,000	3,140	3,720	240	730	430	820	6,400	530	1,180	450
10	55	3,100	2,380	3,900	160	720	430	864	5,800	530	1,500	300
11	50	3,400	2,360	5,000	150	719	430	840	5,200	520	1,560	180
12	50	3,600	2,360	6,000	130	720	420	860	4,550	516	1,600	150
13	50	3,300	2,650	640	120	720	413	990	4,120	490	1,560	110
14	50	4,600	3,480	240	98	720	390	1,030	3,850	470	1,500	95
15	50	4,400	3,750	4,200	100	723	380	1,000	3,450	452	1,500	90
16	50	4,080	3,400	4,510	100	710	363	1,540	3,150	450	1,430	80
17	50	3,900	2,450	5,300	109	690	350	1,620	2,840	440	1,420	78
18	56	3,700	310	320	180	654	340	1,970	2,550	430	1,100	80
19	55	3,600	260	5,300	290	660	340	2,010	2,250	412	1,450	80
20	55	3,700	3,900	5,600	360	600	333	1,880	2,040	390	1,450	290
21	55	3,600	3,600	3,800	470	559	330	1,810	1,920	375	1,440	300
22	55	3,740	3,500	5,500	550	560	420	1,680	1,820	361	1,410	320
23	1,110	3,760	3,450	5,300	610	560	411	1,640	1,700	350	1,400	324
24	2,300	3,300	3,350	5,320	660	560	420	1,640	1,440	345	1,400	190
25	2,200	2,600	3,500	5,330	750	558	520	1,500	1,350	335	1,350	110
26	3,800	2,590	3,370	5,350	860	530	550	1,520	1,240	327	1,300	110
27	800	2,600	2,200	5,360	880	520	732	1,520	1,130	330	1,420	110
28	3,760	2,750	2,300	5,100	884	510	740	1,520	1,100	330	1,230	105
29	6,000	....	4,400	4,600	930	500	750	1,490	1,050	334	1,120	110
30	5,500	....	4,200	1,800	940	470	740	1,480	960	330	1,220	110
31	5,150	....	4,820	....	940	....	710	1,830	....	325	....	110

NOTE.—These discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Salt River at McDowell, Ariz., for 1909.

[Drainage area, 6,260 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	6,000	50	1,200	0.192	0.22	73.800
February	4,600	2,590	3,620	.578	.60	201,000
March	4,820	260	3,050	.487	.56	188.000
April	6,000	240	3,940	.629	.70	234,000
May	3,100	70	544	.087	.10	33,400
June	944	470	681	.109	.12	40,500
July	750	330	468	.075	.09	28,800
August	2,010	560	1,220	.195	.22	75,000
September	6,400	960	2,510	.401	.45	149.000
October	880	325	485	.077	.09	29,800
November	1,600	314	1,130	.180	.20	67.200
December	1,090	78	341	.054	.06	21.000
The year	6,400	50	1,580	.252	3.41	1,140,000

NOTE.—These estimates were recomputed to conform to the computation rules used by the U. S. Geological Survey. The values differ slightly from those computed by the Reclamation Service.

VERDE RIVER AT McDOWELL, ARIZ.

This station, which was established April 20, 1897, is located 30 miles northeast of Phoenix, 15 miles northeast of Mesa, 2⅛ miles above the Arizona canal diversion dam, and three-fourths of a mile above the mouth of the river.

As the bed of the stream at this point is sandy and shifting, frequent measurements are required to properly determine the daily discharge.

This station is maintained by the United States Reclamation Service.

Discharge measurements of Verde River at McDowell, Ariz., in 1909.

[By W. Richins.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-feet.*		*Feet.*	*Sec.-feet.*
Jan. 4	4.30	519	Apr. 2	7.20	2,710
8	4.20	453	6	7.45	2.860
12[a]	4.05	481	9	6.65	1,260
17[a]	6.50	3,650	13	6.65	1,390
20[a]	5.50	1,450	16	6.55	1,240
22[a]	5.10	1,000	20	6.45	1,050
26[a]	6.20	2,720	23	6.15	663
30[a]	5.55	1,500	27	5.80	424
Feb. 3[a]	5.20	954	30	5.60	333
9[a]	5.70	2,240	May 4	5.45	248
12	5.50	1,180	7	5.35	248
16	6.20	2,240	10	5.25	185
19	5.90	1,430	12	5.25	205
23	6.20	1,820	14	5.20	181
26	5.80	1,240	17	5.20	191
Mar. 2	6.35	1,840	19	5.20	184
5	6.50	1,960	21	5.20	191
9	6.60	2,000	25	5.15	162
12	5.95	1,180	28	5.15	165
16	6.35	1,910	June 1	5.10	164
19	6.45	1,760	4	5.10	162
23	6.35	1,500	8	5.05	148
26	6.35	1,470	11	4.95	132
30	7.90	5,700	15	4.90	129

[a] Made by J. C. Leaming.

Discharge measurements of Verde River at McDowell, Ariz., in 1909—Continued.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-feet.*		*Feet.*	*Sec.-feet.*
June 18	4.90	132	Oct. 1	5.60	196
22	4.90	126	5	5.50	161
25	4.90	124	8	5.50	159
29	4.90	114	12	5.50	175
July 2	4.85	119	15	5.50	162
6[a]	5.45	416	19	5.50	162
9	5.10	233	22	5.45	144
13	4.95	160	26	5.45	155
16	4.85	147	29	5.45	156
July 20	5.10	188	Nov. 2	5.45	157
23	5.88	651	5	5.50	227
26	6.80	1,760	8	5.45	181
28	6.75	1,396	9	5.45	194
30	6.05	607	10	5.45	195
Aug. 3	5.60	328	11	5.45	192
6	5.55	310	12	5.50	201
10	6.10	623	16	5.50	245
13	7.30	2,300	17	5.55	267
17	8.08	4,020	19	5.55	254
20	6.90	1,340	23	5.55	241
24	6.50	801	26	5.50	213
27	6.65	1,050	28	5.55	260
31	6.10	492	30	5.60	297
Sept. 3	5.95	398	Dec. 3	5.60	288
7	7.10	1,800	7	5.60	290
8	7.10	1,760	9	5.60	283
10	6.65	828	10	5.65	326
14	6.05	374	14	5.85	472
17	5.85	275	17	5.70	330
21	5.75	247	20	5.65	322
23	5.70	211	23	6.00	503
24	5.65	207	28	5.90	382
29	5.55	180	31	5.80	337

[a] Made from cable.

NOTE.—From June 11 to July 20, excepting July 6, measurements were made about 500 feet above cable by wading. Water too shallow at cable to make an accurate measurement. Beginning July 23, measurements were resumed from the cable.

Daily gage height, in feet, of Verde River at McDowell, Ariz., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	5.50	6.48	7.18	5.55	5.10	4.85	5.70	6.08	5.60	5.45	5.60
2	4.40	5.32	6.40	7.08	5.50	5. 0	4.85	5.62	5.98	5.55	5.45	5.60
3	4.35	5.20	6.40	6.82	5.45	5.10	4.85	5.08	5.92	5.50	5.45	5.60
4	4.30	5.20	6.40	7.15	5.45	5.08	4.85	5.68	5.85	5.50	5.48	5.55
5	4.30	5.20	6.60	7.45	5.40	5.05	4.85	5.62	6.00	5.50	5.50	5.55
6	4.28	5.20	6.82	7.32	5.38	5.05	5.38	5.55	6.78	5.50	5.50	5.62
7	4.22	5.20	6.95	7.05	5.35	5.05	5.30	6.65	7.18	5.50	5.45	5.60
8	4.20	5.20	6.95	6.80	5.30	5.05	5.18	6.05	7.05	5.50	5.45	5.60
9	4.15	5.75	6.58	6.58	5.30	5.00	5.08	6.20	6.78	5.50	5.45	5.60
10	4.15	5.90	6.28	6.50	5.25	4.98	5.02	6.10	6.60	5.50	5.45	5.62
11	4.10	5.70	6.02	6.50	5.25	4.95	5.00	6.22	6.42	5.50	5.45	5.65
12	4.05	5.45	5.95	6.55	5.25	4.95	4.95	6.18	6.20	5.50	5.50	5.70
13	4.05	5.40	5.78	6.65	5.22	4.90	4.92	7.18	6.12	5.50	5.50	5.75
14	4.05	5.80	5.65	6.50	5.20	4.90	4.90	6.72	6.02	5.50	5.50	5.82
15	7.98	6.20	5.60	6.48	5.20	4.90	4.85	7.75	5.92	5.50	5.50	5.78
16	7.50	6.18	6.35	6.65	5.20	4.90	4.82	8.22	5.88	5.50	5.52	5.70
17	6.42	5.92	6.58	6.60	5.20	4.90	4.80	7.92	5.85	5.50	5.55	5.70
18	6.00	5.75	6.40	6.55	5.20	4.90	6.20	7.52	5.80	5.50	5.55	5.70
19	5.75	5.95	6.42	6.52	5.20	4.90	5.22	7.18	5.75	5.50	5.55	5.65
20	5.50	6.08	6.45	6.45	5.20	4.90	5.08	7.12	5.75	5.48	5.55	5.65
21	5.30	6.10	6.40	6.38	5.20	4.90	5.20	7.10	5.75	5.45	5.55	5.68
22	5.10	6.32	6.38	6.25	5.20	4.90	5.52	6.70	5.70	5.45	5.55	5.88
23	5.00	6.15	6.32	6.12	5.15	4.90	5.78	6.48	5.70	5.45	5.55	6.05
24	8.00	5.85	6.15	6.02	5.15	4.90	5.55	6.62	5.65	5.45	5.52	6.05
25	6.90	5.72	6.20	5.95	5.15	4.90	5.42	6.45	5.65	5.45	5.50	6.00
26	6.30	5.82	6.50	5.88	5.15	4.90	6.35	6.70	5.60	5.45	5.50	6.00
27	6.02	5.88	6.95	5.80	5.15	4.90	6.15	6.72	5.60	5.45	5.50	5.92
28	5.85	5.40	6.95	5.75	5.15	4.90	6.70	6.45	5.55	5.45	5.55	5.90
29	5.98	....	8.00	5.68	5.15	4.90	6.28	6.20	5.55	5.45	5.60	5.88
30	5.75	....	7.82	5.60	5.10	4.90	6.00	6.12	5.58	5.45	5.60	5.82
31	5.58	....	7.40	....	5.10	....	5.82	6.08	....	5.45	....	5.80

NOTE.—Gage heights are affected by regulation at Roosevelt dam. Maximum recorded gage heights occurred as follows: Jan. 15, 8.90; Mar. 29, 8.30; July 28, 6.75; Aug. 16, 8.80; Sept. 7, 7.25; Dec. 23, 6.10.

Daily discharge, in second-feet, of Verde River at McDowell, Ariz., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	510	1,360	2,130	2,540	300	164	120	380	480	197	155	290
2	520	1,100	1,920	2,400	270	164	120	340	400	180	157	290
3	520	954	1,860	1,780	250	164	120	360	370	170	160	273
4	519	1,000	1,830	2,370	248	162	120	360	320	160	190	270
5	510	1,050	2,120	2,950	245	150	120	340	420	161	227	270
6	490	1,100	2,550	2,580	245	150	360	320	1,200	160	220	300
7	470	1,150	2,800	1,900	248	150	320	1,400	1,920	160	200	291
8	453	1,200	2,750	1,500	220	149	270	600	1,650	159	181	300
9	450	2,050	1,960	1,160	210	140	230	730	1,080	160	194	299
10	470	2,100	1,490	1,100	187	135	190	626	770	165	195	327
11	480	1,600	1,170	1,120	195	132	180	710	630	165	192	340
12	481	1,250	1,100	1,210	203	130	170	610	470	175	201	350
13	480	1,070	1,000	1,390	190	130	160	2,020	420	165	205	300
14	480	1,550	900	1,130	181	130	155	1,600	380	165	205	472
15	6,800	2,240	900	1,100	190	130	150	3,400	340	162	205	300
16	4,650	2,200	1,910	1,380	190	130	145	4,900	320	162	245	340
17	3,400	1,640	2,030	1,280	191	130	140	3,850	272	162	267	330
18	2,300	1,300	1,790	1,180	190	130	960	2,670	260	162	260	330
19	1,820	1,490	1,720	1,140	185	130	300	1,900	250	162	254	320
20	1,460	1,650	1,720	1,050	190	130	190	1,700	250	155	250	318
21	1,200	1,680	1,610	940	191	130	280	1,820	247	150	250	330
22	1,000	2,500	1,580	790	185	126	440	1,000	220	143	250	400
23	900	1,740	1,500	650	170	125	600	780	211	150	241	500
24	7,000	1,320	1,250	570	170	125	460	970	208	150	230	500
25	4,300	1,160	1,300	520	162	125	390	760	208	150	220	490
26	3,000	1,250	1,690	480	165	120	1,120	1,120	200	151	213	460
27	2,350	1,290	2,550	424	165	120	800	1,150	200	150	220	410
28	1,990	850	2,600	400	166	120	1,350	830	190	150	260	384
29	2,200	....	5,050	370	165	116	810	600	180	154	290	370
30	1,820	....	4,680	333	165	120	560	550	190	155	297	350
31	1,550	....	3,450	....	165	....	420	500	....	155	....	337

NOTE.—These discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Verde River at McDowell, Ariz., for 1909.

[Drainage area, 6,000 square miles.]

Month.	Discharge in second-feet.				Depth in inches on drainage area.	Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	Per square mile.		
January	6,800	450	1,760	0.293	0.34	108,000
February	2,500	850	1,460	.243	.25	81,000
March	5,050	900	2,030	.338	.39	125,000
April	2,950	333	1,260	.210	.23	74,900
May	300	162	200	.033	.04	12,300
June	164	116	135	.022	.02	8,050
July	1,350	120	379	.063	.07	23,300
August	4,900	320	1,260	.210	.24	77,100
September	1,920	180	475	.079	.09	28,300
October	197	143	160	.027	.03	9,840
November	297	155	221	.037	.04	13,200
December	500	270	354	.059	.07	21,800
The year	6,800	116	805	.134	1.81	583,000

MISCELLANEOUS MEASUREMENTS IN COLORADO RIVER DRAINAGE BASIN.

The following miscellaneous discharge measurements were made in Colorado River drainage basin during 1909. They are arranged by drainage basins in downstream order.

Miscellaneous measurements in Colorado River drainage basin in 1909.

Green River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Nov. 13	Lake Fork	Duchesne River	Lower Canyon, Utah		156
June 14	Great Western canal	Cottonwood Creek	Orangeville, Utah		17.3
July 28	do	do	do		12.1
June 14	Clipper canal	do	do	3.2	20.3
July 28	do	do	do	3.5	28.4
June 14	Blue Cut canal	do	do	3.2	54.2
July 27	do	do	do	2.76	34.8
Aug. 23	do	do	do	2.25	4.5
June 15	Mammoth canal	do	do	3.65	30.5
July 27	do	do	do	4.13	43.0
Apr. 28	North canal	Ferron Creek	Ferron, Utah		24.9
June 12	do	do	do	2.65	90.9
July 26	do	do	do	2.50	61.5
Aug. 23	do	do	do	2.00	23.5
Apr. 28	South canal	do	do		21.7
June 12	do	do	do		15.6
July 26	do	do	do		30.5
May 4	Huntington Creek	San Rafael River	At county bridge, near Huntington, Utah.	3.25	68.1
June 18	do	do	do	3.8	696
July 29	do	do	do	1.7	10.1
June 17	Cleveland canal	Huntington Creek	Huntington, Utah	4.0	111
July 29	do	do	do	4.15	129
Aug. 21	do	do	do	2.6	1.5
June 17	North canal	do	do	3.05	51.8
Aug. 21	do	do	do	2.24	15.9
Sept. 21	do	do	do	2.05	2.5
June 17	Huntington canal	do	do	1.7	63.4
Aug. 21	do	do	do	1.0	17.9
Sept. 21	do	do	do	1.0	18.3

Grand River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
Aug. 10	East Inlet to Grand Lake	Grand Lake	Grand Lake, Colo	−4.60	48
June 27	South Fork of Grand River.	Grand River	At Grigg's ranch, near Lehman, Colo.		718
Aug. 9	do	do	Lehman's ranch, Colo	4.80	112
Do	Stillwater Creek	do	King's ranch, near Granby, Colo.		[a] 3
Aug. 11	do	do	do		[a] 3
June 17	Willow Creek	do	One-half mile above mouth, near Dexter, Colo.	6.10	910
May 4	do	do	At mouth, near Spitzer	3.63	85
June 17	do	do	do	6.10	910
Jan. 20	Blue River	do	Governor mine, Colo		1.6
Mar. 23	do	do	Above Breckenridge, Colo.		1.5
Jan. 20	do	do	One-fourth mile above Spruce Creek Plant, near Breckenridge, Colo.		2.1
May 12	do	do	At Breckenridge, Colo		45
Mar 22	do	do	At Dillon, Colo		60
May 12	Ten Mile Creek	Blue River	do		133
July 14	Gypsum Creek	Eagle River	One-fourth mile north of Gypsum, Colo.		79
Jan. 17	Roaring Fork	Grand River	Aspen, Colo		29
Mar. 20	do	do	do		35
Apr. 24	do	do	do		68
Jan. 17	Hunters Creek	Roaring Fork	do		5.6
Mar. 20	do	do	do		5.0
Apr. 24	do	do	do		15
Mar. 20	Castle Creek	do	do	.9	50
Apr. 24	do	do	do	.95	51
Jan. 17	do	do	At mouth, near Aspen, Colo.		61
Apr. 24	Maroon Creek	do	Near Aspen, Colo		17
Jan. 17	do	do	At mouth, near Aspen Colo.		11
Mar. 20	do	do	do		12
Jan. 18	Frying Pan River	do	Thomasville, Colo		34
Mar. 21	do	do	do		48
Do	Lime Creek	Frying Pan River	At mouth, Thomasville, Colo.		9.2
Jan. 14	Crystal River	Roaring Fork	Redstone, Colo	2.40	58

[a] Estimated.

Miscellaneous measurements in Colorado River drainage basin in 1909—Continued.

Grand River basin—Continued.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Mar. 17	Crystal River	Roaring Fork	Redstone, Colo	2.40	56
Jan. 15	do	do	Sewell, Colo	1.85	111
Do	do	do	Hot Springs, Colo		76
Mar. 18	do	do	do		62
Jan. 19	Spruce and Crystal canal	Crystal River	One-fourth mile below headgate.		.5
Jan. 15	Coal Creek	do	Redstone, Colo		6.2
Mar. 17	do	do	do		11
Jan. 15	Avalanche Creek	do	At mouth, Redstone, Colo.		20
Mar. 18	do	do	do		20
Do	Thompson Creek	do	Sewell, Colo		[a]9
Apr. 22	do	do	do	1.12	40
Aug. 26	Whitewater Creek	Gunnison River	One-half mile above head gate of ditch, T. 12 S., R. 98 W., Colorado.		2.3
Oct. 10	do	do	do		2.5
Mar. 4	do	do	One-fourth mile above head gate.		1.3
4	do	do	do		1.4
3	do	do	At head gate of ditch in N. E. ¼ sec. 8, T. 12 S., R. 98 W., Colorado.		1.2
4	do	do	do		1.3
4	do	do	do		1.3
Aug. 25	do	do	do		2.2
26	do	do	do		2.6

Fremont River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
Aug. 29	Upper Fremont Canyon	Fremont River	In Rabbit Valley, Utah		2.5
Do	Right Fork of Fremont River.	do	do		6.0
Aug. 26	Ivy Creek	do	do		2.0
Aug. 28	Solomon Creek	do	do		2.0
Aug. 30	Bulberry Creek	do	do		.6
Do	Donkey Creek	do	do		2.0
Aug. 11	Sand Creek	do	do		2.0
Do	Fish Creek	do	do		1.5
Aug. 12	Grover Creek	do	do		1.8
June 30	Torry canal	do	In Rabbit Valley, Utah, (near Loa).		11
Aug. 30	do	do	In Rabbit Valley, Utah		3.0
Aug. 13	Oak Creek	do	do		3.0
Aug. 26	Queatah-up-pah canal	do	do		1.8
July 26	Muddy Creek	do	At county bridge, near Emery, Utah.		5.6
June 13	Independent canal	Muddy Creek	Emery, Utah	2.15	7.9
Do	Emery canal	do	do	3.90	60.4
Aug. 25	do	do	do	3.43	13.7

San Juan River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
Sept. 30	San Juan River	Colorado River	Above mouth of Piedras River, near Arboles, Colo.		[a]200
Do	Navajo Creek	San Juan River	At mouth, near Pajosa Junction, Colo.		[a]25
Do	Piedras River	do	At Arboles, Colo		[a]100
Do	Los Pinos River	do	At railroad bridge at La Boca, Colo.		[a]60
Do	Spring Creek	Los Pinos River	At La Boca, Colo		[a]10
Do	Rio Florida	Animas River	At Denver and Rio Grande railroad crossing, south of Durango, Colo.		[a]20

Little Colorado River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
Apr. 7	Manuelito Creek	Little Colorado River	Manuelito, N. Mex	[b]— .41	8.4
May 24	do	do	do	[b]— .35	17.7
June 26	do	do	do	[b]—1.03	.2

[a] Estimated.

[b] Distance down from reference mark to water surface.

Miscellaneous measurements in Colorado River drainage basin in 1909—Continued.

Virgin River basin.

Date	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Oct. 13	Virgin River	Colorado River	Above Zion Creek, near Springdale, Utah.		48.5
Do.	Zion Creek	Virgin River	Just above mouth, near Springdale, Utah.		62.5
July 12	Hurricane canal	do	Near Virgin, Utah		13.7
Do.	La Verkin canal	do	do		11.9
July 14	South side Santa Clara canal.	Santa Clara River	Near Santa Clara, Utah		2.6
Do.	North side Santa Clara canal.	do	do		4.9
July 15	Six Mile Flat canal	do	Near Central, Utah		2.8
July 14	South side St. George canal.	do	Near St. George, Utah		4.1
Do.	North side St. George canal.	do	do		3.1
Do.	Seep canal	do	do		4.8
Oct. 18	Pinto Creek		Near Pinto, Utah		4.3

Gila River basin.

Date	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
Apr. 25	Gila River	Colorado River	7 miles above Gila Farm, N. Mex.	1.40	256
Do.	Mogollon River	Gila River	1 mile above mouth, above Gila, N. Mex.		48
Apr. 19	Duck Creek	do	Cliff, N. Mex	5.10	3
Oct. 9	do	do	do		[a]3
Do.	Mangus Creek	do	Mangus, N. Mex		[a]1
Feb. 7	Whitewater Creek	San Francisco River	Glenwood, N. Mex	[b]— .38	8.3
Apr. 21	do	do	do	[b]— .14	84
June 6	do	do	do	[b]— .42	25
July 4	do	do	do	[b]— .60	9.8
Oct. 9	do	do	do		[a]6.5

---

[a] Estimated.

[b] Distance down from reference point to water surface. Reference point is a staple driven into root of large cottonwood tree about 20 feet downstream from tree which is the second one on the right bank above the ford.

INDEX.

A. Page.

- Accuracy, degree of 26-27
- Acknowledgments to those aiding 29-30
- Acre-foot, definition of 14
- Alamo River near—
  - Brawley, Cal.:
    - description 50
    - discharge 50
    - discharge, daily 51
    - discharge, monthly 51
    - gage heights 50
- Alma, N. Mex.,
  - San Francisco River at:
    - description 222
    - discharge 222
    - discharge, daily 223
    - discharge, monthly 224
    - gage heights 223
- Animas River at—
  - Aztec, N. Mex.:
    - description 194
    - discharge 194
    - discharge, daily 195
    - discharge, monthly 196
    - gage heights 195
- Animas River, flood in 190
  - flood scenes, plates showing 190
- Appropriations, amount of 7
- Arboles, Colo.,
  - Piedras River at:
    - discharge 234
  - San Juan River near:
    - discharge 234
- Arrow, Colo.,
  - Middle Ranch Creek near:
    - description 142,144
    - discharge 142,145
    - discharge, daily 143-144,146-147
    - discharge, monthly 144,147
    - gage heights 143,145-146
  - South Ranch Creek near:
    - description 147,150
    - discharge 148,150
    - discharge, daily 149,151-152
    - discharge, monthly 149,152
    - gage heights 148,150-151
- Aspen, Colo.,
  - Castle Creek near:
    - discharge 233
  - Hunters Creek near:
    - discharge 233
  - Maroon Creek near:
    - discharge 233
  - Roaring Fork near:
    - discharge 233
- Authority for investigations 7
- Aztec, N. Mex., Page.
  - Animas River at:
    - description 194
    - discharge 194
    - discharge, daily 195
    - discharge, monthly 196
    - gage heights 195
  - flood scene at, plate showing 190

B.

- Basalt, Colo.,
  - Frying Pan River at:
    - description 161-162
    - discharge 162
    - discharge, daily 163
    - discharge, monthly 163
    - gage heights 162
- Big Jim Creek near—
  - Fraser, Colo.:
    - description 118
    - discharge 118
    - discharge, daily 120
    - discharge, monthly 122
    - gage heights 119
- Blanco, N. Mex.,
  - San Juan River at:
    - description 191
    - discharge 191
    - discharge, daily 102-193
    - discharge, monthly 193
    - gage heights 192
- Blue Cut canal near—
  - Orangeville, Utah:
    - discharge 233
- Blue River at—
  - Breckenridge, Colo.:
    - discharge 233
  - Dillon, Colo.:
    - discharge 233
- Bolster, R. H., work of 30
- Brawley, Cal.,
  - Alamo River near:
    - description 50
    - discharge 50
    - discharge, daily 51
    - discharge, monthly 51
    - gage heights 50
  - New River near:
    - description 51-52
    - discharge 52
    - gage heights 52
- Breckenridge, Colo.,
  - Blue River at:
    - discharge 233
- Bulberry Creek, discharge of 234

C. Page.

- Carbondale, Colo.,
  - Crystal River near:
    - description 163-164
    - discharge 164
    - discharge, daily 165
    - discharge, monthly 165
    - gage heights 164
- Castle Creek near—
  - Aspen, Colo.:
    - discharge 233
- Central, Utah,
  - Santa Clara River near:
    - description 212-213
    - discharge 213
    - discharge, daily 214
    - discharge, monthly 214
    - gage heights 213
  - Six Mile Flat canal near:
    - discharge 235
- Central Colorado Power Co., cooperation of 29
- Chatfield, C. L., work of 30
- Clapp, W. B., work of 30
- Clear Creek near—
  - Winslow, Ariz.:
    - description 205
    - gage heights 205
- Cleveland canal near—
  - Huntington, Utah:
    - discharge 233
- Cliff, N. Mex.,
  - Duck Creek near:
    - discharge 235
- Clipper Canal near—
  - Orangeville, Utah:
    - discharge 233
- Colorado, cooperation of 29
- Colorado River drainage basin, general features of 34-35
- Colorado River, and Green River, description of 35-39
- Colorado River at—
  - Yuma, Ariz.:
    - description 44-45
    - discharge 45-46
    - discharge, daily 47
    - discharge, monthly 47
    - gage heights 46-47
- Colorado Yule Marble Co., plant of, plate showing 164
- Computing, office methods in 22-26
- Cooperation, credit for 29-30
- Cooperative data for stations in Fraser River drainage basin 112-113
- Cottonwood Creek near—
  - Orangeville, Utah:
    - description 81-82
    - discharge 82
    - discharge, daily 83
    - discharge, monthly 83
    - gage heights 82
- Crystal River near—
  - Carbondale, Colo.:
    - description 163-164
    - discharge 164
    - discharge, daily 165
    - discharge, monthly 165
    - gage heights 164

Crystal River near—Continued. Page.

  - Hot Springs, Colo.:
    - discharge 234
  - Redstone, Colo.:
    - discharge 233-234
  - Sewell, Colo.:
    - discharge 234
- Current meter, description of 19-20
  - use of 18, 20-21
  - views of 20
- Current-meter stations, views of 18

D.

- Definitions of terms used 13-14
- Delta, Colo.,
  - Uncompahgre River near:
    - description 178
    - discharge 179
    - gage heights 179
- Dexter, Colo.,
  - Willow Creek near:
    - discharge 233
- Dillon, Colo.,
  - Blue River at:
    - discharge 233
  - Tenmile Creek at:
    - discharge 233
- Discharge, computation of 22-26
  - determination of, plate showing 24
  - measurement of 16-21
- Discharge measurements, nature of 15-16
- Divide Creek drainage basin, description of 165
  - *See* West Divide Creek.
- Donkey Creek, discharge of 234
- Drainage, stream flow and 9-10
- Drainage basins, list of 10
- Duchesne River basin, description of 52-55
- Duchesne River at—
  - Myton, Utah:
    - description 55
    - discharge 56
    - discharge, daily 57
    - discharge, monthly 57
    - gage heights 56
- Duck Creek near—
  - Cliff, N. Mex.:
    - discharge 235
- Durango, Colo., flood scene at, plate showing 190
  - Rio Florida near:
    - discharge 234

E.

- Eagle River basin, description of 155
- Eagle River at—
  - Gypsum, Colo.:
    - description 155
    - discharge 155
    - discharge, daily 156
    - discharge, monthly 157
    - gage heights 156
- East Jim Creek, *see* Big Jim Creek.
- Elk Creek near—
  - Fraser, Colo.:
    - description 129
    - discharge 129
    - discharge, daily 131
    - discharge, monthly 132
    - gage heights 130

- Emery, Utah, Page.
  - Emery canal near:
    - discharge 234
  - Independent canal near:
    - discharge 234
  - Muddy Creek near:
    - description 181-182
    - discharge 182
    - discharge, daily 182
    - discharge, monthly 183
    - gage heights 182
- Emery canal near—
  - Emery, Utah:
    - discharge 234
- Equivalents, list of 14-15
- Escalante, Utah,
  - Escalante Creek near:
    - description 183
    - discharge 184
    - discharge, daily 184
    - discharge, monthly 184
    - gage heights 184
- Escalante Creek near—
  - Escalante, Utah:
    - description 183
    - discharge 184
    - discharge, daily 184
    - discharge, monthly 184
    - gage heights 184
- Escalante River drainage basin. description of 183
- Evaporation at Holbrook, Ariz 203-205

F.

- Ferron, Utah,
  - Ferron Creek near:
    - description 83-84
    - discharge 84
    - discharge, daily 85
    - discharge. monthly 85
    - gage heights 84
  - North canal near:
    - discharge 233
  - South canal near:
    - discharge 233
- Ferron Creek near—
  - Ferron, Utah:
    - description 83-84
    - discharge 84
    - discharge, daily 85
    - discharge, monthly 85
    - gage heights 84
- Field practice, methods of 16-21
- Fish Creek, discharge of 234
- Fletcher, R. H., work of 30
- Float method, description of 19
- Flood in Animas River, plates showing 190
- Flood in San Juan Valley, general features of 187-188
  - rainfall during 188-189
  - résumé of 190-191
  - rivers, behavior during 189-190
    - Animas River 190
    - La Plata River 190
    - San Juan River 189
- Flood in Zuni River valley, general features of 206-210
  - views of, plates showing 206, 208
- Flood prevention, stream flow and 10
- Fort Crawford, Colo., Page.
  - Uncompahgre River at:
    - description 174
    - discharge 175
    - discharge, daily 175
    - discharge, monthly 175
    - gage heights 175
- Fort Duchesne, Utah,
  - Uinta River at:
    - description 72
    - discharge 73
    - discharge, daily 74
    - discharge, monthly 74
    - gage heights 73
- Fraser, Colo.,
  - Big Jim Creek near:
    - description 118
    - discharge 118
    - discharge, daily 120
    - discharge, monthly 121
    - gage heights 119
  - Elk Creek near:
    - description 129
    - discharge 129
    - discharge, daily 131
    - discharge, monthly 132
    - gage heights 130
  - Fraser River near:
    - description 113, 115
    - discharge 113, 115
    - discharge, daily 114, 117
    - discharge, monthly 115, 118
    - gage heights 113-114, 116
  - Little Jim Creek near:
    - description 121
    - discharge 121
    - discharge, daily 122-123
    - discharge, monthly 123
    - gage heights 122
  - St. Louis Creek near:
    - description 132, 134
    - discharge 132, 135
    - discharge, daily 133-134, 136
    - discharge, monthly 134, 136
    - gage heights 133, 135
  - Vasquez River near:
    - description 124, 126
    - discharge 124, 126
    - discharge, daily 125, 128
    - discharge, monthly 126, 129
    - gage heights 124-125, 127
- Fraser River basin, description of 110
  - stations in, cooperative data for 112-113
- Frazer River at or near—
  - Fraser, Colo.; lower station:
    - description 115
    - discharge 115
    - discharge, daily 117
    - discharge, monthly 118
    - gage heights 116
  - Fraser, Colo.; upper station:
    - description 113
    - discharge 113
    - discharge, daily 114
    - discharge, monthly 115
    - gage heights 113-114

- Fraser River at or near—Continued.
  - Granby, Colo.: Page.
    - description 110
    - discharge 110
    - discharge, daily 111
    - discharge, monthly 112
    - gage heights 111
- Freeman, W. B., work of 30
- Fremont River drainage basin, description of. 179
  - miscellaneous measurements in 234
- Fremont River near—
  - Thurber, Utah:
    - description 179–180
    - discharge 180
    - discharge, daily 181
    - discharge, monthly 181
    - gage heights 180
- Fremont River, Right Fork of, discharge of. 234
- Frying Pan River at—
  - Basalt, Colo.:
    - description 161–162
    - discharge 162
    - discharge, daily 163
    - discharge, monthly 163
    - gage heights 162
  - Thomasville, Colo.:
    - discharge 233
- Fuller, E. S., work of 30

G.

- Gage heights, nature of 15
- Gaging stations, classification of 22–24
  - description of 18
  - list of 30–34
- Gila, N. Mex.,
  - Mogollon River near:
    - discharge 235
- Gila River drainage basin, description of 217–218
  - miscellaneous measurements in 235
- Gila River near—
  - Redrock, N. Mex.:
    - description 219
    - discharge 219
    - discharge, daily 220–221
    - discharge, monthly 221
    - gage heights 220
  - Gila Farm, N. Mex.:
    - discharge 235
- Glenwood, N. Mex.,
  - Whitewater Creek near:
    - discharge 235
- Glenwood Springs, Colo.,
  - Grand River at:
    - description 100
    - discharge 100
    - discharge, daily 101
    - discharge, monthly 102
    - gage heights 101
  - Roaring Fork at:
    - description 159–160
    - discharge 160
    - discharge, daily 161
    - discharge, monthly 161
    - gage heights 160
- Granby, Colo.,
  - Fraser River at:
    - description 110
    - discharge 110
- Granby, Colo.—Continued.
  - Fraser River at—Continued. Page.
    - discharge, daily 111
    - discharge, monthly 112
    - gage heights 111
  - Grand River at:
    - description 92–93
    - discharge 93
    - discharge, daily 94
    - discharge, monthly 94
    - gage heights 93
  - Stillwater Creek near:
    - discharge 233
- Grand Lake, Colo.,
  - Grand Lake, east inlet, near:
    - discharge 233
  - Grand Lake, north inlet to, at:
    - description 105
    - discharge 105
  - Grand Lake, outlet, at:
    - description 105–106
    - discharge 106
    - discharge, daily 107
    - discharge, monthly 107
    - gage heights 106
  - Grand River, North Fork of, at:
    - description 90
    - discharge 91
    - discharge, daily 92
    - discharge, monthly 92
    - gage heights 91
- Grand Lake, east inlet to, near—
  - Grand Lake, Colo.:
    - discharge 233
- Grand Lake, north inlet to, at—
  - Grand Lake, Colo.:
    - description 105
    - discharge 105
- Grand Lake outlet at—
  - Grand Lake, Colo.:
    - description 105–106
    - discharge 106
    - discharge, daily 107
    - discharge, monthly 107
    - gage heights 106
- Grand River drainage basin, description of 87–90
  - miscellaneous measurements in 233–234
- Grand River at or near—
  - Glenwood Springs, Colo.:
    - description 100
    - discharge 100
    - discharge, daily 101
    - discharge, monthly 102
    - gage heights 101
  - Granby, Colo.:
    - description 92–93
    - discharge 93
    - discharge, daily 94
    - discharge, monthly 94
    - gage heights 93
  - Kremmling, Colo.:
    - description 97
    - discharge 98
    - discharge, daily 99
    - discharge, monthly 99
    - gage heights 98

- **Grand River at or near—Continued.**
  - Palisades, Colo.: Page.
    - description, 102
    - discharge, 103
    - discharge, daily, 104
    - discharge, monthly, 104
    - gage heights, 103
  - Sulphur Springs, Colo.:
    - description, 94-95
    - discharge, 95
    - discharge, daily, 96
    - discharge, monthly, 97
    - gage heights, 96
- Grand River, North Fork of, near—
  - Grand Lake, Colo.:
    - description, 90
    - discharge, 91
    - discharge, daily, 92
    - discharge, monthly, 92
    - gage heights, 91
- Grand River, South Fork of, near—
  - Lehman, Colo.:
    - description, 107-108
    - discharge, 108, 233
    - discharge, daily, 109
    - discharge, monthly, 109
    - gage heights, 108
- Great Western canal near—
  - Orangeville, Utah:
    - discharge, 233
- Green River, and the main Colorado River, description of, 35-39
- Green River drainage basin, miscellaneous measurements in, 233
- Green River at—
  - Greenriver, Utah:
    - description, 39-40
    - discharge, daily, 41-43
    - discharge, monthly, 43-44
    - gage heights, 40
- Greenriver, Utah,
  - Green River at:
    - description, 39-40
    - discharge, daily, 41-43
    - discharge, monthly, 43-44
    - gage heights, 40
  - San Rafael River near:
    - description, 79
    - discharge, 80
    - discharge, daily, 81
    - discharge, monthly, 81
    - gage heights, 80
- Grover Creek, discharge of, 234
- Gunnison River drainage basin, description of, 169-172
- Gunnison River at—
  - River Portal, Colo.:
    - description, 172
    - discharge, 173
    - discharge, daily, 173
    - discharge, monthly, 174
    - gage heights, 173
- Gypsum, Colo.,
  - Eagle River at:
    - description, 155
    - discharge, 155
    - discharge, daily, 156
- Gypsum, Colo.—Continued.
  - Eagle River at—Continued. Page.
    - discharge, monthly, 157
    - gage heights, 156
  - Gypsum Creek near:
    - discharge, 233
- Gypsum Creek near—
  - Gypsum, Colo.:
    - discharge, 233

H.

- Hardy, W. V., work of, 30
- Helper, Utah,
  - Price River near:
    - description, 77
    - discharge, 77
    - discharge, daily, 78
    - discharge, monthly, 79
    - gage heights, 78
- Hoebig, A. H., jr., work of, 30
- Holbrook, Ariz., monthly rainfall, evaporation, and temperature at, 203-205
- Holbrook, Ariz.,
  - Little Colorado River at:
    - description, 202
    - gage heights, 203
- Hunters Creek near—
  - Aspen, Colo.:
    - discharge, 233
- Huntington, Utah,
  - Cleveland Canal near:
    - discharge, 233
  - Huntington Canal near:
    - discharge, 233
  - Huntington Creek near:
    - description, 85-86
    - discharge, 86, 233
    - discharge, daily, 87
    - discharge, monthly, 87
    - gage heights, 86, 233
  - North Canal near:
    - discharge, 232
- Huntington Canal near—
  - Huntington, Utah:
    - discharge, 233
- Huntington Creek near—
  - Huntington, Utah:
    - description, 85-86
    - discharge, 86, 233
    - discharge, daily, 87
    - discharge, monthly, 87
    - gage heights, 86
- Hurricane Canal near—
  - Virgin, Utah:
    - discharge, 235

I.

- Ice, measurements under, 21, 26
- Independent Canal near—
  - Emery, Utah:
    - discharge, 234
- Indian Creek in—
  - Strawberry Valley:
    - description, 62-63
    - discharge, 63
    - discharge, daily, 63
    - discharge, monthly, 63
    - gage heights, 63

- **Indian Creek,**
  - **Strawberry River above mouth of:** Page.
    - description 58
    - discharge 58
    - discharge, daily 58
    - discharge, monthly 59
    - gage heights 58
  - **Strawberry River below mouth of:**
    - description 60-61
    - discharge 61
    - discharge, daily 62
    - discharge, monthly 62
    - gage heights 61
- **Indian Office, cooperation of** 29
- **Investigations, authority for** 7
  - purposes of 9-10
  - scope of 8
- **Irrigation, stream flow and** 9
- **Ivy Creek, discharge of** 234

J.

- **Jackson, H. J., work of** 30
- **Jones, H. A., work of** 30

K.

- **King, L. T., work of** 30
- **Kremmling, Colo.,**
  - Grand River at:
    - description 97
    - discharge 98
    - discharge, daily 99
    - discharge, monthly 99
    - gage heights 98

L.

- **La Boca, Colo.,**
  - Los Pinos River at:
    - discharge 234
  - Spring Creek at:
    - discharge 234
- **Lake Fork near—**
  - Lower Canyon, Utah:
    - discharge 233
  - Myton, Utah:
    - description 67
    - discharge 68
    - discharge, daily 69
    - discharge, monthly 69
    - gage heights 68
  - Whiterocks, Utah:
    - description 65
    - discharge 65
    - discharge, daily 66
    - discharge, monthly 67
    - gage heights 66
- **Lake Fork, reservoir site on West Fork of, plate showing** 54
- **La Plata, N. Mex.,**
  - La Plata River at:
    - description 196
    - discharge 197
    - discharge, daily 198
    - discharge, monthly 199
    - gage heights 197
- **La Plata River at—**
  - La Plata, N. Mex.:
    - description 196
    - discharge 197
    - discharge, daily 198

La Plata River at—Continued.

- La Plata, N. Mex.—Continued. Page.
  - discharge, monthly 199
  - gage heights 197
- **La Plata River, flood in** 190
- **La Rue, E. C., work of** 30
- **La Verkin Canal near—**
  - Virgin, Utah:
    - discharge 235
- **Lehman, Colo.,**
  - Grand River, South Fork of, near—
    - description 107-108
    - discharge 108, 233
    - discharge, daily 109
    - discharge, monthly 109
    - gage heights 108, 233
- **Lime Creek near—**
  - Thomasville, Colo.:
    - discharge 233
- **Little Colorado River drainage basin,**
  - description of 200
  - miscellaneous measurements in 234
- **Little Colorado River at—**
  - Holbrook, Ariz.:
    - description 202
    - gage heights 203
  - St. Johns, Ariz.:
    - description 200
    - discharge 200
    - discharge, daily 201
    - discharge, monthly 202
    - gage heights 201
  - Woodruff, Ariz.:
    - description 202
- **Little Jim Creek near—**
  - Fraser, Colo.:
    - description 121
    - discharge 121
    - discharge, daily 122-123
    - discharge, monthly 123
    - gage heights 122
- **Loa, Utah,**
  - Torry canal near:
    - discharge 234
- **Los Pinos River at—**
  - La Boca, Colo.:
    - discharge 234
- **Lower Canyon,**
  - Lake Fork near:
    - discharge 233
- **Lyons, Thomas, assistance of** 29

M.

- **McChristie, M. E., work of** 30
- **McDowell, Ariz.,**
  - Salt River at:
    - description 227
    - discharge 228
    - discharge, daily 229
    - discharge, monthly 230
    - gage heights 229
  - Verde River at:
    - description 230
    - discharge 230-231
    - discharge, daily 232
    - discharge, monthly 232
    - gage heights 231
- **Mamm Creek drainage basin, description of** 168
  - *See* West Mamm Creek.

- **Mammoth Canal near—**
  - Orangeville, Utah: Page.
    - discharge, 233
- **Mangus, N. Mex.,**
  - Mangus Creek near:
    - discharge, 235
- **Mangus Creek near—**
  - Mangus, N. Mex.:
    - discharge, 235
- **Manning ditch, near—**
  - Tucson, Ariz.:
    - discharge, 225
- **Manuelito, N. Mex.—**
  - Manuelito Creek near:
    - discharge, 234
- **Manuelito Creek near—**
  - Manuelito, N. Mex.:
    - discharge, 234
- **Maroon Creek near—**
  - Aspen, Colo.:
    - discharge, 233
- **Martin, W. F., work of**, 30
- **Mathers, J. G., work of**, 30
- **Means, H. C., work of**, 30
- **Middle Box Canyon of Gila River, plate showing**, 164
- **Middle Ranch Creek near—**
  - Arrow, Colo.; lower station:
    - description, 144
    - discharge, 145
    - discharge, daily, 146-147
    - discharge, monthly, 147
    - gage heights, 145-146
  - Arrow, Colo.; upper station:
    - description, 142
    - discharge, 142
    - discharge, daily, 143-144
    - discharge, monthly, 144
    - gage heights, 143
- **Miller, C. D., work of**, 30
- **Miner's inch, definition of**, 13
- **Miscellaneous measurements in—**
  - Fremont River basin, 234
  - Gila River basin, 235
  - Grand River basin, 233-234
  - Green River basin, 233
  - Little Colorado River basin, 234
  - San Juan River basin, 234
  - Virgin River basin, 235
- **Moapa, Nev.,**
  - Muddy River near:
    - description, 216
    - discharge, 216
- **Mogollon River near—**
  - Gila, N. Mex.:
    - discharge, 235
- **Montrose, Colo.,**
  - Uncompahgre River at:
    - description, 176
    - discharge, 176
    - discharge, daily, 177
    - discharge, monthly, 178
    - gage heights, 177
- **Muddy Creek near—**
  - Emery, Utah:
    - description, 181-182
    - discharge, 182
    - discharge, daily, 182
- **Muddy Creek near—Continued.**
  - Emery, Utah—Continued. Page.
    - discharge, monthly, 183
    - gage heights, 182
- **Muddy River near—**
  - Moapa, Nev.:
    - description, 216
    - discharge, 217
- **Myton, Utah,**
  - Duchesne River at:
    - description, 55
    - discharge, 56
    - discharge, daily, 57
    - discharge, monthly, 57
    - gage heights, 56
  - Lake Fork near:
    - description, 67
    - discharge, 68
    - discharge, daily, 69
    - discharge, monthly, 69
    - gage heights, 68

N.

- **Navajo Creek near—**
  - Pagosa Junction, Colo.:
    - discharge, 234
- **Navigation, stream flow and**, 9
- **New Mexico, cooperation of**, 29
- **New River near—**
  - Brawley, Cal.:
    - description, 51-52
    - discharge, 52
    - gage heights, 52
- **Nogales, Ariz.,**
  - Santa Cruz River at:
    - description, 224
    - gage heights, 224
- **North canal near—**
  - Ferron, Utah:
    - discharge, 233
  - Huntington, Utah:
    - discharge, 233
- **North Ranch Creek near—**
  - Rollins Pass, Colo.; lower station:
    - description, 139
    - discharge, 139
    - discharge, daily, 141
    - discharge, monthly, 142
    - gage heights, 140
  - Rollins Pass, Colo.; upper station:
    - description, 137
    - discharge, 137
    - discharge, daily, 138
    - discharge, monthly, 139
    - gage heights, 137-138

O.

- **Oak Creek, discharge of**, 234
- **Office practice, methods of**, 22-26
- **Orangeville, Utah,**
  - Blue Cut canal near:
    - discharge, 233
  - Clipper canal near:
    - discharge, 233
  - Cottonwood Creek near:
    - description, 81-82
    - discharge, 82
    - discharge, daily, 83

- Orangeville, Utah—Continued.
  - Cottonwood Creek near—Continued. Page.
    - discharge, monthly 83
    - gage heights 82
  - Great Western canal near:
    - discharge 233
  - Mammoth canal near:
    - discharge 233

P.

- Padgett, H. D., work of 30
- Pagosa Junction, Colo.,
  - Navajo Creek near:
    - discharge 234
- Palisades, Colo.,
  - Grand River at:
    - description 102
    - discharge 103
    - discharge, daily 104
    - discharge, monthly 104
    - gage heights 103
- Phelan, J. J., work of 30
- Piedras River at—
  - Arboles, Colo.:
    - discharge 234
- Pinto, Utah,
  - Pinto Creek near:
    - discharge 235
- Pinto Creek near—
  - Pinto, Utah:
    - discharge 235
- Porter, E. A., work of 30
- Price River basin, description of 77
- Price River near—
  - Helper, Utah:
    - description 77
    - discharge 77
    - discharge, daily 78
    - discharge, monthly 79
    - gage heights 78
- Publications, lists of 10-13

Q.

- Queatah-up-pah Canal, discharge of 234

R.

- Rabbit Valley, streams in, discharge of 234
- Rating curves, construction and use of 22
- Rating tables, construction of 22
  - nature of 16
- Raven, Colo.,
  - West Divide Creek at or near:
    - description 166
    - discharge 166
    - discharge, daily 167
    - discharge, monthly 167
    - gage heights 166, 167
- Reclamation Service, cooperation of 29
- Redrock, N. Mex.,
  - Gila River near:
    - description 219
    - discharge 219
    - discharge, daily 220-221
    - discharge, monthly 221
    - gage heights 220
- Redstone, Colo.,
  - Avalanche Creek at:
    - discharge 234
  - Coal Creek near:
    - discharge 234
- Redstone, Colo.—Continued.
  - Crystal River near: Page.
    - discharge 233-234
- Revision, need for 27-28
- Rice, R. C., work of 30
- Rifle, Colo.,
  - West Mamm Creek near:
    - description 168
    - discharge, daily 169
    - discharge, monthly 169
    - gage heights 168
- Rio Florida near—
  - Durango, Colo.:
    - discharge 234
- River Portal, Colo.,
  - Gunnison River at:
    - description 172
    - discharge 173
    - discharge, daily 173
    - discharge. monthly 174
    - gage heights 173
- Roaring Fork basin, description of 157
- Roaring Fork at or near—
  - Aspen, Colo.:
    - discharge 233
  - Emma, Colo.:
    - description 157
    - discharge 158
    - discharge, daily 159
    - discharge, monthly 159
    - gage heights 158
  - Glenwood Springs, Colo.:
    - description 159-160
    - discharge 160
    - discharge, daily 161
    - discharge, monthly 161
    - gage heights 160
- Rollins Pass, Colo.,
  - North Ranch Creek, near:
    - description 137, 139
    - discharge 137, 139
    - discharge, daily 138, 141
    - discharge, monthly 139, 142
    - gage heights 137-138, 140
- Run-off, computation of 22-26
  - definition of 13
- Russell, G. H., work of 30

S.

- St. George, Utah,
  - St. George Canal near:
    - discharge 235
  - Santa Clara River near:
    - description 214-215
    - discharge 215
    - discharge, daily 216
    - discharge, monthly 216
    - gage heights 215
  - Seep canal near:
    - discharge 235
- St. George Canal near—
  - St. George, Utah:
    - discharge 235
- St. Johns, Ariz.,
  - Little Colorado River at:
    - description 200
    - discharge 200
    - discharge, daily 201
    - discharge, monthly 202
    - gage heights 201

- St. Louis Creek near—
  - Fraser, Colo., lower station: Page.
    - description 134
    - discharge 135
    - discharge, daily 136
    - discharge, monthly 136
    - gage heights 135
  - Fraser, Colo., upper station:
    - description 132
    - discharge 132
    - discharge, daily 133–134
    - discharge, monthly 134
    - gage heights 133
- Salton, Cal.,
  - Salton Sea near:
    - description 48–49
    - gage heights 49
    - rise, monthly 49
- Salton Sea near—
  - Salton, Cal.:
    - description 48–49
    - gage heights 49
    - rise, monthly 49
- Salton Sink, description of 48–49
- Salt River drainage basin, description of 227
- Salt River at—
  - McDowell, Ariz.:
    - description 227
    - discharge 228
    - discharge, daily 229
    - discharge, monthly 230
    - gage heights 229
- Sand Creek, discharge of 234
- San Francisco River at—
  - Alma, N. Mex.:
    - description 222
    - discharge 222
    - discharge, daily 223
    - discharge, monthly 224
    - gage heights 223
- San Juan River drainage basin, description of 185–187
  - flood of Sept. 5 and 6, 1909, in, general features of 187–188
    - Animas River, behavior of, during 190
    - La Plata River, behavior of, during 190
    - rainfall during 188–189
    - résumé of 190–191
    - San Juan River, behavior of, during 189
  - map showing 188
  - miscellaneous measurements in 234
- San Juan River at or near—
  - Arboles, Colo.:
    - discharge 234
  - Blanco, N. Mex.:
    - description 191
    - discharge 191
    - discharge, daily 192–193
    - discharge, monthly 193
    - gage heights 192
- San Juan River, flood in 189
- San Rafael River drainage basin, description of 79
- San Rafael River near—
  - Greenriver, Utah:
    - description 79
    - discharge 80
    - discharge, daily 81
- San Rafael River near—Continued.
  - Greenriver, Utah—Continued. Page.
    - discharge, monthly 81
    - gage heights 80
- Santa Clara, Utah,
  - Santa Clara canal near:
    - discharge 235
- Santa Clara canal near—
  - Santa Clara, Utah:
    - discharge 235
- Santa Clara River near—
  - Central, Utah:
    - description 212–213
    - discharge 213
    - discharge, daily 214
    - discharge, monthly 214
    - gage heights 213
  - St. George, Utah:
    - description 214–215
    - discharge 215
    - discharge, daily 216
    - discharge, monthly 216
    - gage heights 215
- Santa Cruz River at or near—
  - Nogales, Ariz.:
    - description 224
    - gage heights 224
  - Tucson, Ariz.:
    - description 225
    - discharge 225
    - discharge, monthly 226
- Second-feet per square mile, definition of 13
- Second-foot, definition of 13
- Section, changes in, estimation for 23–25
- Seep canal near—
  - St. George, Utah:
    - discharge 235
- Sewell, Colo.,
  - Crystal River near:
    - discharge 234
  - Thompson Creek near:
    - discharge 234
- Six Mile Flat canal near—
  - Central, Utah:
    - discharge 235
- Slope method, description of 17
- Snelson, W. H., work of 30
- Solomon Creek, discharge of 234
- South canal near—
  - Ferron, Utah:
    - discharge 233
- South Ranch Creek near—
  - Arrow, Colo., lower station:
    - description 150
    - discharge 150
    - discharge, daily 151–152
    - discharge, monthly 152
    - gage heights 150–151
  - Arrow, Colo.; upper station:
    - description 147
    - discharge 148
    - discharge, daily 149
    - discharge, monthly 149
    - gage heights 148
- Spitzer, Colo.,
  - Willow Creek near:
    - discharge 233

Page.

- Spring Creek at—
  - La Boca, Colo.:
    - discharge ... 234
- Springdale, Utah,
  - Virgin River near:
    - discharge ... 235
  - Zion Creek near:
    - discharge ... 235
- Spruce and Crystal Canal, discharge of ... 234
- Stewart, J. B., work of ... 30
- Stillwater Creek near—
  - Granby, Colo.:
    - discharge ... 233
- Strawberry River—
  - above mouth of Indian Creek:
    - description ... 58
    - discharge ... 58
    - discharge, daily ... 58
    - discharge, monthly ... 59
    - gage heights ... 58
  - below mouth of Indian Creek:
    - description ... 59
    - discharge ... 59
    - discharge, daily ... 60
    - discharge, monthly ... 60
    - gage heights ... 60
- Strawberry River at—
  - Theodore, Utah:
    - description ... 60-61
    - discharge ... 61
    - discharge, daily ... 62
    - discharge, monthly ... 62
    - gage heights ... 61
- Strawberry Valley,
  - Indian Creek in:
    - description ... 62-63
    - discharge ... 63
    - discharge, daily ... 63
    - discharge, monthly ... 63
    - gage heights ... 63
  - Trail Hollow Creek in:
    - description ... 64
    - discharge ... 64
    - discharge, daily ... 64
    - discharge, monthly ... 64
    - gage heights ... 64
- Stream measurements, accuracy of ... 26-27
  - data of, use of ... 28
  - methods of ... 16-21
- Sullivan, V. L., work of ... 30
- Sulphur Springs, Colo.,
  - Grand River at:
    - description ... 94-95
    - discharge ... 95
    - discharge, daily ... 96
    - discharge, monthly ... 97
    - gage heights ... 96
  - Williams Fork at:
    - description ... 153
    - discharge ... 153
    - discharge, daily ... 154
    - discharge, monthly ... 155
    - gage heights ... 154
- Swamps, drainage of, stream flow and ... 9-10

T. Page.

- Tables, explanation of ... 15-16
- Terms, definition of ... 13-14
- Thomasville, Colo.,
  - Frying Pan River near:
    - discharge ... 233
  - Lime Creek near:
    - discharge ... 233
- Thompson Creek near—
  - Sewell, Colo.:
    - discharge ... 234
- Thurber, Utah,
  - Fremont River near:
    - description ... 179-180
    - discharge ... 180
    - discharge, daily ... 181
    - discharge, monthly ... 181
    - gage heights ... 180
- Torry Canal, discharge of ... 234
- Trail Hollow Creek in—
  - Strawberry Valley:
    - description ... 64
    - discharge ... 64
    - discharge, daily ... 64
    - discharge, monthly ... 64
    - gage heights ... 64
- Tucson, Ariz.,
  - Santa Cruz River and ditches at:
    - description ... 225
    - discharge ... 225
    - discharge, monthly ... 226

U.

- Uinta River at or near—
  - Fort Duchesne, Utah:
    - description ... 72
    - discharge ... 73
    - discharge, daily ... 74
    - discharge, monthly ... 74
    - gage heights ... 73
  - Whiterocks, Utah:
    - description ... 70
    - discharge ... 71
    - discharge, daily ... 71
    - discharge, monthly ... 72
- Uncompahgre River at or near—
  - Delta, Colo.:
    - description ... 178
    - discharge ... 179
    - gage heights ... 179
  - Fort Crawford, Colo.:
    - description ... 174
    - discharge ... 175
    - discharge, daily ... 175
    - discharge, monthly ... 175
    - gage heights ... 175
  - Montrose, Colo.:
    - description ... 176
    - discharge ... 176
    - discharge, daily ... 177
    - discharge, monthly ... 178
    - gage heights ... 177
- Upper Fremont Canyon, discharge of ... 234
- Utah, cooperation of ... 29

V. Page.

- Vasques River near—
  - Fraser, Colo., lower station:
    - description 126
    - discharge 126
    - discharge, daily 128
    - discharge, monthly 129
    - gage heights 127
  - Fraser, Colo., upper station:
    - description 124
    - discharge 124
    - discharge, daily 125
    - discharge, monthly 126
    - gage heights 124-125
- Velocity method, description of 17-21
- Verde River at—
  - McDowell, Ariz.:
    - description 230
    - discharge 230-231
    - discharge, daily 232
    - discharge, monthly 232
    - gage heights 231
- Vickery, R. E., assistance of 29
- Virgin, Utah—
  - Hurricane canal near:
    - discharge 235
  - La Verkin canal near:
    - discharge 235
- Virgin, Utah,
  - Virgin River at:
    - description 210-211
    - discharge 211
    - discharge, daily 212
    - discharge, monthly 212
    - gage heights 211
- Virgin River drainage basin, description of 210
  - miscellaneous measurements in 235
- Virgin River at or near—
  - Springdale, Utah:
    - discharge 235
  - Virgin, Utah:
    - description 210-211
    - discharge 211
    - discharge, daily 212
    - discharge, monthly 212
    - gage heights 211

W.

- Walters, M. I., work of 30
- Water power, stream flow and 9
- Water supply, stream flow and 9
- Weir method, description of 17
- West Divide Creek at or near—
  - Raven, Colo.:
    - description 166
    - discharge 166
    - discharge, daily 167
    - discharge, monthly 167
    - gage heights 167
- West Jim Creek, *see* Little Jim Creek.
- West Mamm Creek near—
  - Rifle, Colo.:
    - description 168
    - discharge, daily 169
    - discharge, monthly 169
    - gage heights 168
- Whiterocks, Utah,
  - Lake Fork near:
    - description 65
    - discharge 65

Whiterocks, Utah—Continued. Page.

  - Lake Fork near—Continued.
    - discharge, daily 66
    - discharge, monthly 67
    - gage heights 66
  - Uinta River near:
    - description 70
    - discharge 71
    - discharge, daily 71
    - discharge, monthly 72
    - gage heights 71
  - Whiterocks River near:
    - description 74-75
    - discharge 75
    - discharge, daily 76
    - discharge, monthly 76
    - gage heights 75
- Whiterocks River near—
  - Whiterocks, Utah:
    - description 74-75
    - discharge 75
    - discharge, daily 76
    - discharge, monthly 76
    - gage heights 75
- Whitewater Creek, Colo., discharge of 234
- Whitewater Creek near—
  - Glenwood, N. Mex.:
    - discharge 235
- Williams Fork basin, description of 153
- Williams Fork near—
  - Sulphur Springs, Colo.:
    - description 153
    - discharge 153
    - discharge, daily 154
    - discharge, monthly 155
    - gage heights 154
- Williams Fork, site for reservoir, plate showing 54
- Willow Creek near—
  - Dexter, Colo.:
    - discharge 233
  - Spitzer, Colo.:
    - discharge 233
- Winslow, Ariz.,
  - Clear Creek near:
    - description 205
    - gage heights 205
- Wood, Mrs. B. D., work of 30
- Woodruff, Ariz.,
  - Little Colorado River at:
    - description 202
- Work, division of 30

Y.

- Yuma, Ariz.,
  - Colorado River at:
    - description 44-45
    - discharge 45-46
    - discharge, daily 47
    - discharge, monthly 47
    - gage heights 46-47

Z.

- Zion Creek near—
  - Springdale, Utah:
    - discharge 235
- Zuni dam failure, plates showing 206, 208
- Zuni Reservoir, log of 208
- Zuni River drainage basin, flood in 206-210
  - map of 207
  - rainfall in 208